

# ANNALS of SURGERY

A Monthly Review of Surgical Science and Practice

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# ANNALS *of* SURGERY

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## THE MAKING OF A SURGEON

BY JOHN B. ROBERTS, M.D.  
OF PHILADELPHIA, PA.

ABSTRACT OF PRESIDENTIAL ADDRESS DELIVERED AT THE MEETING OF THE AMERICAN SURGICAL ASSOCIATION,  
JUNE 14, 1921.

EDUCATION in the Medical Specialties has been given a great deal of attention by our profession within recent years. Surgery has been developed to such a degree of accuracy that the training of those fitted to practice its various subspecialties satisfactorily, honestly and safely has become of paramount importance. The mental and moral equipment of a medical graduate seeking professional and public support in his operative surgical efforts should be subjected to a searching analysis.

This organization of teachers and research workers in surgery is one of the agencies which may well devote time to the consideration of The Making of Surgeons. The President therefore has grouped observations of some early writers on surgical teaching from the time of Paracelsus down to the present century.

When Paracelsus at the University of Basel, in Switzerland, insisted that he would teach not in the Latin of the scholastics, but in the language of his hearers, and laid stress on personal observation and research in surgical education, he opened the way to modern surgery. Arderne and Gale, in England, subsequently prepared text-books in English for the training of anatomists and operators. Later, John Hunter and his pupils developed the surgical science and art in England, from which our particular Fellowship has largely drawn inspiration and skill.

This line of study soon brought me to the lives and work of men with whom we who now guide, to a considerable extent, the surgical thought of our respective medical schools and communities came into personal contact.

A review of the methods of study which developed Samuel David Gross, the founder of the American Surgical Association, William Williams Keen, a survivor of the original active Fellows, and a glance at the life work of its Associate Fellows, Marion Sims, Joseph Lister, Theodore Kocher, Victor Horsley and William C. Gorgas, give evidence of what is needed to make Surgical Science have a spirit of efficiency, mercy and altruism. These men have transmitted to this assembly of my colleagues a glorious heritage.

A conviction has been brought to me, by these studies, that a maximum

of success up to the limit of an individual's native capacity may be best obtained by certain educational equipments acquired prior to the entrance into the undergraduate medical school and after release from the now usual hospital internship.

A real surgeon should have knowledge of logic, psychology, ethics and at least a familiarity with the fundamental processes of rather advanced mathematics and of chemistry and physics. Otherwise, how can he be expected to accurately use his reason to understand and interpret the mysteries of biochemistry, physiology, and the physical processes of life?

Similarly he needs, particularly in a surgical career, a working knowledge of general mechanics and should have some training of his hands and fingers, by which his cerebral centres will be stimulated to specific reactions.

In addition to an acquaintance with Latin, he should know some Greek. These tongues lie at the basis of medical nomenclature.

With this equipment, let him enter the medical school, wherein among other topics, Medical History should not be neglected.

The hospital internship, now so wisely insisted upon in some States, should be followed by at least one or two years general practice. This should, if possible, be under the partial supervision of an internist of ability, conscientious temperament and endowed with a practical knowledge of how to care for distempered souls as well as impaired bodily organs.

The youth is now ready to begin a preparatory course for a true Chirurgical Life—the happiest, the best and the most glorious of man's efforts for his fellow-men. In this graduate study, he must return to first principles and renew acquaintance with anatomy, morbid anatomy, pathology, physics and chemistry with eyes, ears and a brain of an intellectually receptive mind. The sciences allied to medicine will be part of his systematic study.

He should later make application of his basic education in science and medicine and his renewal of scholastic topics to the diagnosis and treatment, operative, medical and physico-therapeutic, of surgical conditions, under wise guidance; and, finally, by research work in connection with his operative opportunities, take place among the recognized surgeons of his country.

## CARCINOMA OF THORACIC OESOPHAGUS EXTRAPLEURAL RESECTION AND PLASTIC\*

DESCRIPTION OF AN ORIGINAL METHOD WITH REPORT OF A SUCCESSFUL  
CASE WITHOUT GASTROSTOMY.

By HOWARD LILIENTHAL, M.D.  
OF NEW YORK, N. Y.

For many years cancer of the thoracic oesophagus had been the despair of surgery. Then, in 1913 came the brilliant achievement of Franz Torek, of New York, who relieved a woman over sixty years of age by boldly invading the posterior mediastinum through the pleura and, in the face of discouraging obstacles, extirpating the tumor-bearing gullet. And his patient is alive today, swallowing her food through an external tube of rubber which completes the passage between an oesophageal opening in the upper thorax and a gastrostomy. In spite of the perhaps trivial annoyance of keeping two wounds clean, the state of this patient is by no means melancholy, and the success of the operation has been the cause of perhaps hundreds of attempts not only to repeat the feat of Torek, but to place transpleural thoracic resection of the oesophagus among the justifiable operations of surgery. But unfortunately neither Torek himself nor any of his followers has been able to save another of these patients while hundreds of failures have resulted. So surely did the fatality follow the operation that some conservative surgeons believed that Torek's success was far from being a benefit to humanity.

Doctor Bevan, speaking at the 1915 meeting of the American Surgical Association, appeared to doubt the wisdom of continuing the operative attack upon the thoracic part of the oesophagus. For some years radium and the X-rays have taken the place of the knife with what seems to me a less merciful ending; for the last day was merely put off with false hopes, longer suffering and greater expense to the patient or his friends.

Probably the greatest danger in oesophageal surgery has been infection of the mediastinum, whether the avenue of approach has been through the pleura or outside of it; and many experiments have been made to avoid this great peril. At the end of this paper is a list compiled for me by Dr. S. Hirshfeld, of New York. It by no means gives all the references in the literature, but it covers the various sides of the subject pretty well.

The only successful cases recorded are those in which some form of oesophagoplasty or anastomosis has been made for benign stricture without resection. Much ingenuity has been shown in devising tubes of skin or hollow viscera, all placed extrathoracically, to side-track the impervious part of the gullet, even the stomach itself having been drawn out of the abdomen and transplanted to take the place of a part of the oesophagus.

About four years ago I began to give serious thought to the problem, and

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\* Read before the American Surgical Association, June 14, 1921.

it occurred to me that in order to avoid mediastinal infection it would be necessary to divide the procedure into at least two parts: First, the exploratory isolation of the œsophagus with obliteration of the mediastinum, and, second, the resection and plastic. I hoped to enter the chest from behind and without invading the pleural cavity. Different levels of the œsophagus might demand various modifications of the method selected, but I finally decided to try out the possibilities with growths occupying the œsophagus below the aortic arch.

I was by no means sure that enough of the pleura could be stripped free



FIG. 1.—The skin flap dissected off and the beginning of the incision in the denuded area. The incision may be extended upward or downward posteriorly.

to make safe the work on the œsophagus. I hoped that even if the pleura were to be injured the method itself need not be abandoned. It would simply mean that the interval between the isolation of the œsophagus and its resection would have to be sufficiently long for the pleural infection to have disappeared. Through the kindness of Dr. J. McAllister I was enabled to test the method on a cadaver in the morgue of Bellevue Hospital. Dr. Harold Neuhof, Associate Surgeon to Mt. Sinai Hospital, assisted me in this investigation as well as in the operative work on living subjects. I am glad to acknowledge here his sympathy and his resourcefulness which did



## CARCINOMA OF THORACIC ŒSOPHAGUS

much to smooth the way in solving this difficult clinical problem. We found, as I feared, that the pleura stripped with difficulty in the subject upon which we worked, but we believed that another pleura might prove more resistant to handling.

The question came up as to whether the approach should be from the left or the right of the spine, and from a fairly large experience in thoracic surgery I concluded that the left approach, although no nearer the œsophagus than the right, would probably prove simpler and safer. First, because the

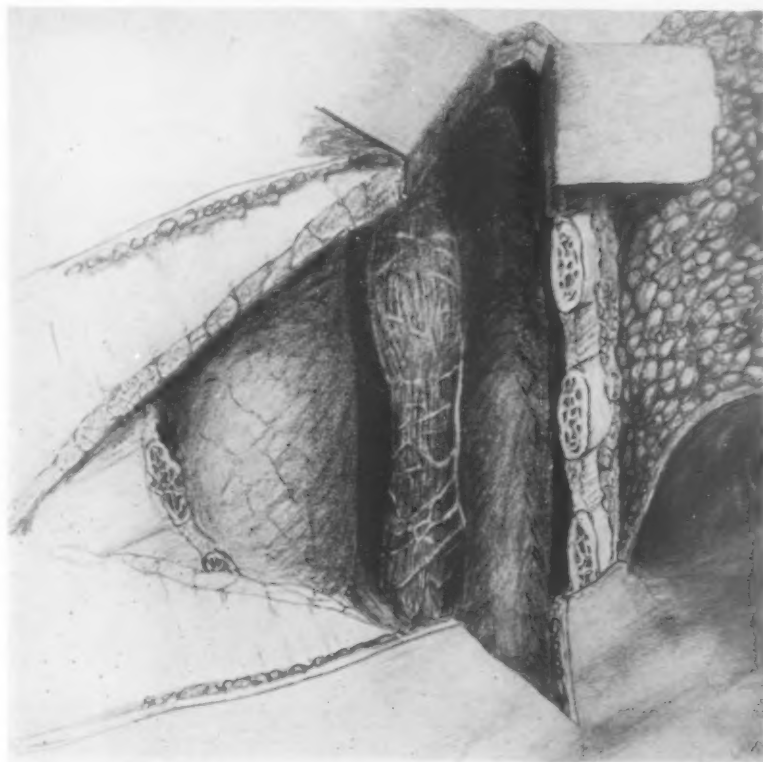


FIG. 2.—Œsophagus exposure. Note lung covered by pleura. Aorta. Œsophagus and (probably) the right vagus with its plexus gularis.

descending aorta would form the first important landmark; second, because we would be further away from the important veins and the thoracic duct, and, third, because working on the right side it would be difficult and perhaps impossible to free the pleural fold which crosses the median line in this part of the thorax. Indeed, in doing a left transpleural operation upon the œsophagus I had once entered the right pleura in loosening the gullet from its bed. The demonstration on the cadaver proved conclusively that it was quite feasible to reach the œsophagus through a sufficiently large wound without the resection of many long pieces of rib. It could probably be done even without costectomy, merely dividing several ribs close to the spine, cut-

ting the intercostal structures down to the pleura, then after peeling off the pleura gradually spreading the wound. We finally concluded that the subperiosteal removal of six or seven inches of one rib would facilitate the pleural stripping and subsequent exposure of the mediastinum. I realized that it would probably be necessary to transplant skin by grafting of some kind in order to prevent cicatricial closure of the space between the severed ends of the œsophagus. How this was finally accomplished the history of my case and the illustrations will explain.

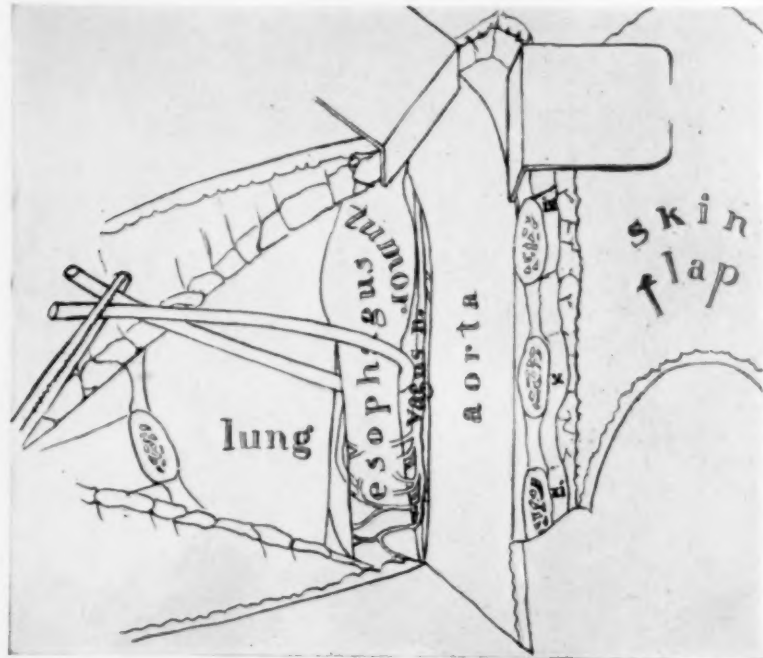


FIG. 3.—Diagrammatic, to explain in part Fig. 2. Note also the rubber tube placed round the œsophagus to act as a retractor.

CASE.—Davis F., thirty-four years of age, entered Mt. Sinai Hospital on December 14, 1920. For a year there had been cough with slight expectoration. There was some nasal obstruction which caused him to be a mouth breather. About nine months before admission he began to suffer pain behind the sternum from the neck to the epigastrium on swallowing solids. For three months he was obliged to wash down his meals with draughts of fluid on account of the presence of an obstruction. I am indebted to Dr. Sidney Yankauer for referring this patient to me, Doctor Yankauer having removed through the œsophagus a specimen which was pronounced by Doctor Mandlebaum to be carcinoma of the squamous cell type.

The Wassermann blood examination was reported as 4+. Further examination by Doctor Yankauer failed to show the full extent of the tumor because the obstruction left a passage too small for his instruments to pass. The general physical examination showed nothing remarkable. The urine analysis was negative. The blood was apparently normal and belonged to Group II. There had,

## CARCINOMA OF THORACIC ŒSOPHAGUS

of course, been loss of weight, but the general nutrition had not greatly suffered. The X-ray films brought by the patient when he entered the hospital were not satisfactory except to demonstrate an obstruction, which could be seen close to the dome of the diaphragm, and a narrow streak of barium running downward from the supposed location of the tumor, through the shadow of the diaphragm until it was lost below. Fluoroscopically there was partial obstruction, which was interpreted by the men of the X-ray staff as being just above the cardia. It is best in these cases not to depend upon the fluoroscope alone, but to have good

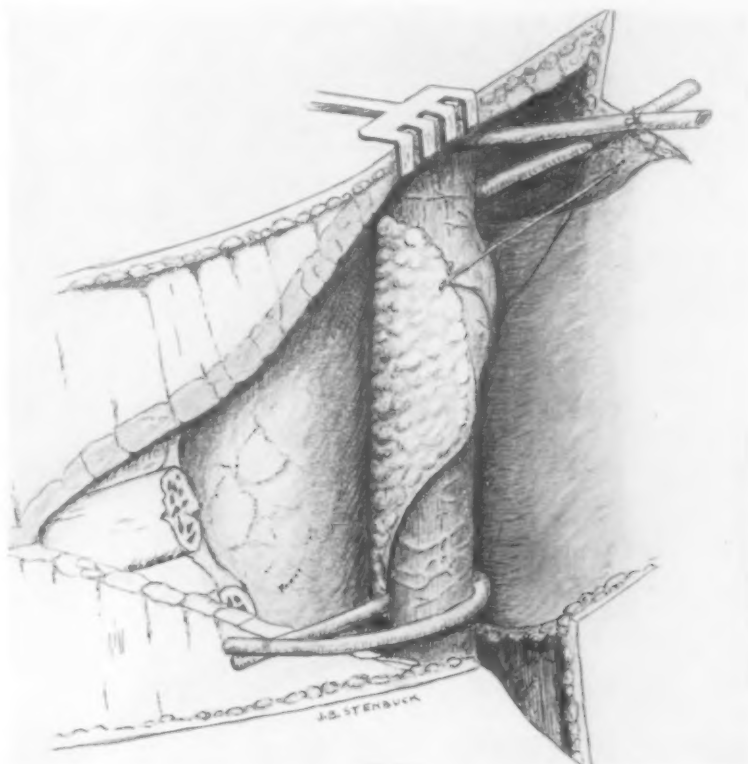


FIG. 4.—Skin flap partly surrounding œsophagus and held in place by a suture to the chest wall. The two rubber tubes are left in place to act as retractors at the next step of the operation.

plates or films made taking in the entire chest so that the level of the tumor may be designated by the corresponding vertebra.

With a positive diagnosis of carcinoma of the œsophagus, probably low down and reported by the X-ray Department to be "two inches above the cardia," operation was undertaken December 16, 1920. The anæsthetic, nitrous oxide-ether, was administered by Doctor Branower, Doctor Neuhoof acting as first assistant, and Dr. J. Lawrence Jones, House Surgeon, as second assistant.† An intravenous

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† I desire to acknowledge the conscientious attention, also, of the surgeons of my House Staff, Dr. L. Mason Lyons having taken the place of Doctor Jones soon after the operation.

injection of six grammes of sodium citrate in solution was administered by Doctor Hirshfeld to reduce the coagulating time of the blood.†

The patient was placed on his right side, with his knees and hips flexed and the trunk bowed forward. The bridge of the table was raised so as to cause a scoliosis with the convexity toward the left. The incision was made from a point about one and a half inches to the left of the spine along the eighth interspace to the mid-axillary line, then downward and backward along the tenth rib, outlining a skin flap with its pedicle posterior. This flap was now dissected up together with the subcutaneous fat and here and there a bit of fascia and muscle, and turned back and wrapped in warm moist towels. (See Fig. 1.) Five

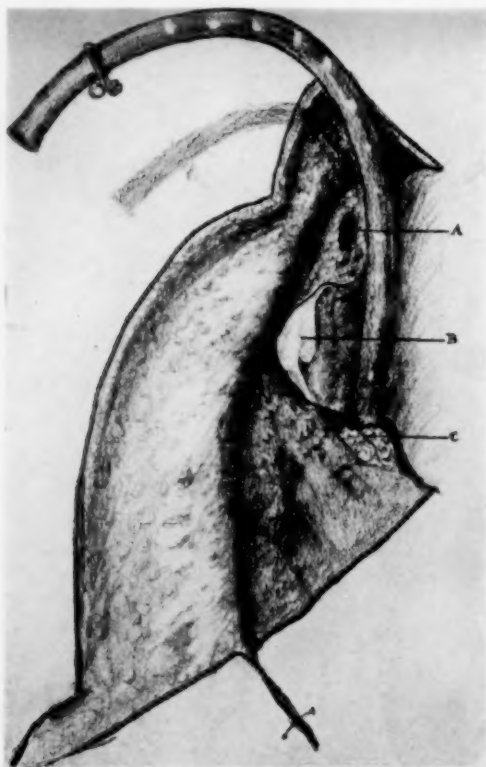


FIG. 5.—After the resection. Stomach tube in lower esophageal orifice and the skin flap upon which the rubber stomach tube rests. The white portion is the granulating side of the flap, not the epidermal side. The mediastinum is obliterated by granulation tissue which also covers the other structures in the picture.

excellent drawings were finished from sketches made at the operation. The artist is Dr. J. B. Stenbuck, Senior on the House Staff of Mt. Sinai Hospital. Through the resulting wound area another incision was made upon the ninth rib, the greater part of which was subperiosteally resected. Beginning toward the back the pleura was dissected with the finger away from the posterior chest wall, and then forward from under the surface of the tenth rib, which was

† A method of Dr. Harold Neuhof. See paper by Neuhof and Hirshfeld in New York Med. Jour., Jan. 15, 1921, vol. cxiii, No. 3, p. 95.



## CARCINOMA OF THORACIC OESOPHAGUS

divided posteriorly close to its angle, after it had been freed from the underlying pleura. With the pleura peeled away and the lung pushed forward with it, the structures in the posterior portion of the thorax were exposed and easily recognized (Figs. 2 and 3). The first important landmark was the great splanchnic nerve and the next the descending aorta from which the pleura separated easily. A stomach tube was passed through the mouth into the oesophagus down to, and finally through, a resistance (at the level of the tumor) which had been quite easily overcome, then on into the stomach. The oesophagus below the tumor was thus rendered palpable as it lay anterior to the aorta, drawn forward by its connection with the pleura much as the ureter is drawn forward

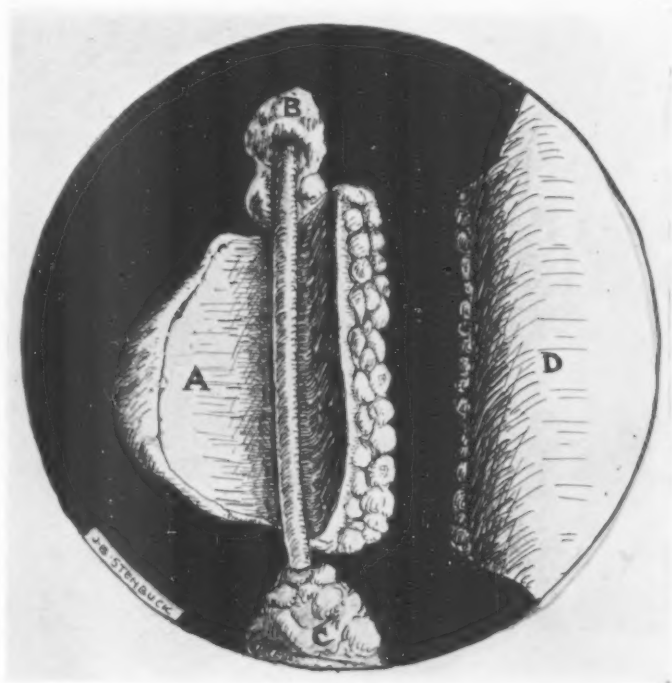


FIG. 6.—Skin flap cut through and rolled over a rubber tube toward the tip of the flap A. D is the pedicle of the flap, now no longer a part of it. B and C are the upper and lower oesophageal openings bridged by the tube.

with the peritoneum. No tumor was felt as far down as the opening through the diaphragm, which, by the way, was exposed with ease, and the opening explored with the finger. A portion of the eighth rib was now freed from the pleura and a short resection done. Then the seventh and sixth ribs were divided posteriorly, also extrapleurally, and the rib separator introduced retracting the entire wound, especially the upper portion. The lower part could be exposed even without the rib spreader. Now the tumor could be distinctly felt as a fusiform enlargement of the oesophagus about three inches below the arch of the aorta and extending upward to about one and a half inches below the arch. The oesophagus was isolated and the right pneumogastric nerve freed from it, dividing the branches with scissors so that the nerve lay on the posterior wall of the chest. Following the advice of Torek this nerve had been anesthetized with five per cent. cocain solution on a pledget of cotton. The left vagus was not seen.

It was probably separated bluntly from the œsophagus during the freeing of this structure from the pleura. A thin rubber tube was now passed around the œsophagus above the tumor and another below it, these tubes acting as suspension ligatures so that the œsophagus with its tumor was nicely exposed, making a beautiful demonstration for spectators. The skin flap was now placed in position, lying between the vagus and the gullet, its cuticular surface being next to the œsophagus and its terminal portion being turned around the viscus so as to form a trough of skin to be completed into a tube by the division of the pedicle of the flap at another time. The skin flap was held in position by a suture of silk running from the tip of the flap to the inner part of the chest wall (Fig. 4). Thus far the pleura had remained intact, but now an additional portion of the

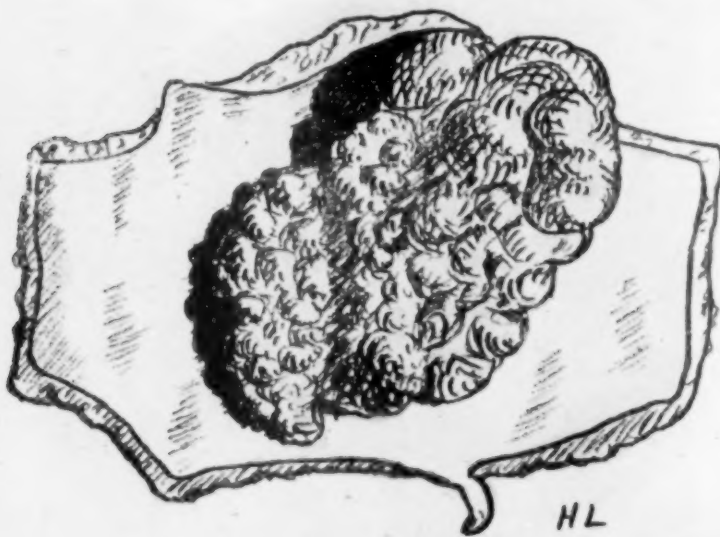


FIG. 7.—The tumor. Œsophageal segment laid open. The line below is the natural size.

eighth rib was resected and there occurred an accidental tear about one-half centimetre square. The lung which had been sliding smoothly against the inner side of the pleura changed its appearance the moment a little air entered, but the opening was quickly and completely closed by catgut sutures. Three heavy chromicized catgut stitches placed pericostally between the tenth and eighth ribs approximated what remained of these ribs, and the anterior part of the wound was closed by suturing the divided muscles, the posterior portion remaining open.

*Dressing.*—The pleura was covered with a large piece of rubber dam extending down as far as the œsophagus which, with its partially surrounding skin flap, lay at the bottom of the wound in its normal position. The remainder of the wound was lightly packed with gauze so as not to make pressure on the flap. No bandage or binder was used, the dressing being held in place by adhesive strips.

There was no shock following this extensive procedure. The patient lay comfortably on his right side. There was some mucus in the trachea, but the man was strong and easily able to expel it. He swallowed better than before the operation, possibly because of the dilation by the stomach tube. His highest temperature was about  $102^{\circ}$ , his pulse 112, but always strong.

My next note is December 23rd, one week after the operation. The gauze

## CARCINOMA OF THORACIC ŒSOPHAGUS

had been removed and replaced and the rubber dam had been taken out a day or two before. The tongue of skin flap which surrounded the œsophagus was slightly discolored, but only about one-half inch at the tip finally necrosed.

December 29th, the wound looked well and granulation had begun. The cough had persisted with about two ounces of expectoration in twenty-four hours. Later it completely disappeared.



FIG. 8.—X-ray in oblique position about three months after the operation. Thick barium mixture. The arrow points to the new œsophagus (the part made from the skin flap). This part is partially empty. Note structure above it.

December 29th, thirteen days after the operation, swallowing became increasingly difficult; so it was decided to perform the second step without delay. A hypodermic of one-fourth grain of morphine and one-one hundred and fiftieth grain of atropine was administered and the patient taken to the operating room. Doctor Neuhof and Dr. Ira Cohen assisted at this stage, and we were glad to have Doctor Torek present as a spectator. There was no anæsthesia, either local or general, and the patient sat up across the table bending forward and making no complaint throughout. Granulating adhesions between the ends of the severed ribs were broken down with the fingers and large blunt retractors were used to

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(X-rays from the Radiographic Department, Mt. Sinai Hospital, Dr. Leopold Jaches, Director.)

expose the depths of the wound. Adhesions had taken place between the œsophagus and the underlying structures and even between the œsophagus and the edges of the skin flap. It was easy to find our way, however, because of the long rubber tubes which had been left around the œsophagus at the close of the previous operation. The entire œsophagus was covered with healthy granulations, but the tumor was still both palpable and visible in spite of this.

The œsophagus was entered with scissors just above the tumor and an

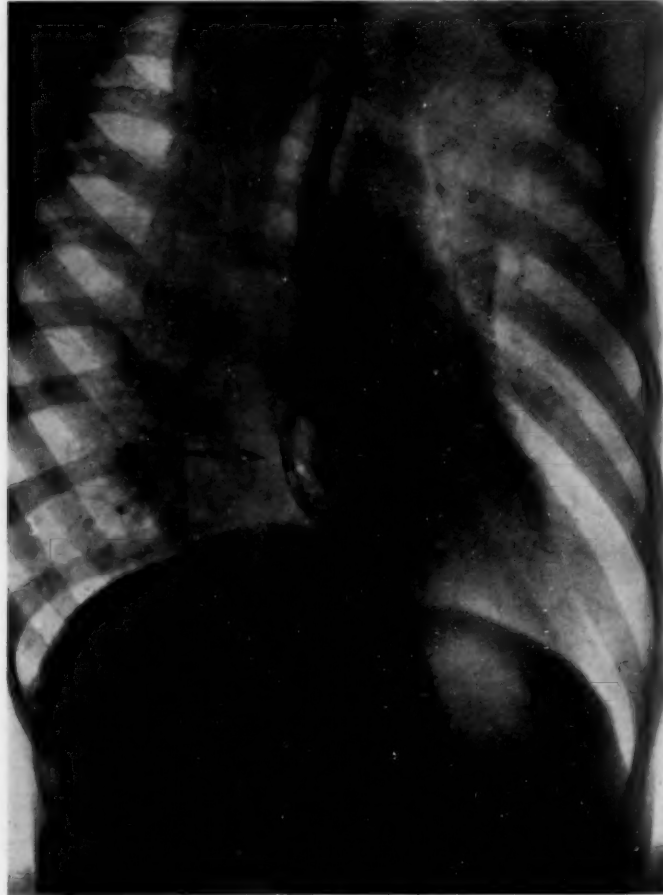


FIG. 9.—Five months after operation. The wound is healed. X-ray in oblique position, with thick barium mixture. The stricture has been dilated. The arrow points to new œsophagus.

incision was made transversely below it. With one blade of the scissors in the lumen, the œsophageal canal was opened in a sagittal direction so that the finger could be inserted for exploration. The tumor limits were easily made out, the cross section of the gullet above was completed, the diseased segment drawn with forceps out of the trough of skin, and the resection completed below. An immediate examination of the specimen showed that we were well beyond the limits of the growth, but to make doubly sure a small segment above this was cut away with the scissors. Hemorrhage was slight, no vessels being caught and no spurters seen. There was a little oozing in the upper portion of the wound. The



## CARCINOMA OF THORACIC ŒSOPHAGUS



FIG. 10.—A red rubber stomach tube has been passed by the patient. In this oblique position the canal appears fairly straight.

skin flap had already formed a trough and the mediastinum was sealed off by it and by granulation tissue. A "T" tube had been prepared, the cross-bar of which was to enter the upper and lower portions of the œsophagus while the upright protruded from the wound for feeding. This proved impossible, however, because the injected fluid went in both directions and regurgitated from above. A swallow of water at once demonstrated that there would be escape alongside of the tube in the upper segment of the œsophagus. The whole wound was lightly packed with gauze and the patient sent to bed in splendid condition. His color was good, his pulse strong, and there was a smile on his face. About one and a half hours later, however, it was found that he had bled considerably from a small artery in the upper segment of the œsophagus. Retractors exposed the depths of the wound and the vessel was caught by Doctor Neuhof with a clamp, which was left in place. Although the pulse had risen to 120 and the patient was pale and somewhat shocked from the loss of blood, his condition was not desperate. A second dose of sodium citrate was given by Doctor Hirshfeld, subcutaneously, this time, although all the bleeding had ceased since the vessel

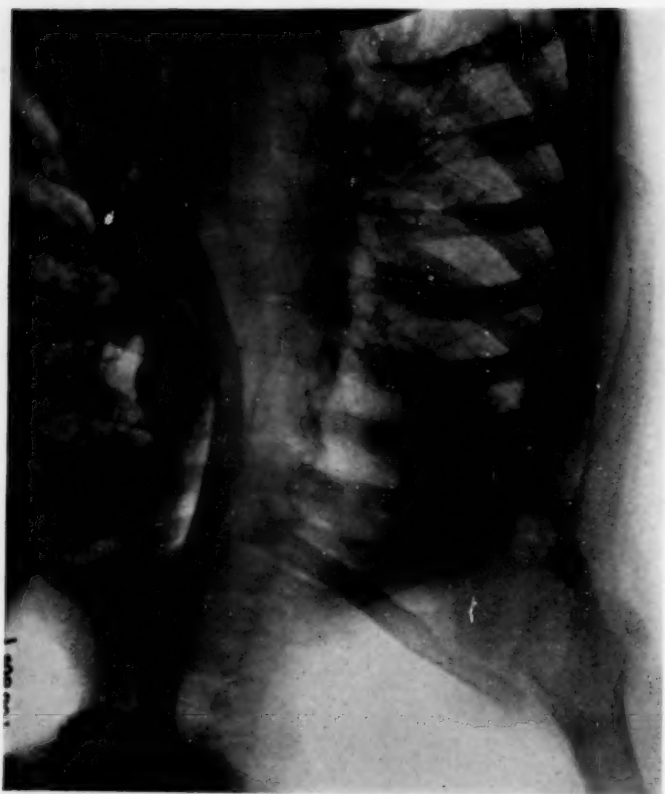


FIG. 11.—Antero posterior view at same sitting as Fig. 10. Note bend in œsophagus.

had been clamped. A few hours later the pulse-rate had receded to 116 and there was great improvement. Still not wishing to omit any precaution, I requested that a transfusion be performed, and this was done by Doctor Ottenberg, who injected 500 c.c. of blood by the citrate method. From that time on the patient never gave us a moment's anxiety so far as danger to his life was concerned. Two days after the operation he was able to sit up during the dressing and the clamp came away without mishap. The "T" tube having proved useless was replaced by a stomach tube, passed through the wound into the lower segment of the œsophagus, and thus he was fed with the aid of a funnel and without regurgitation (Fig. 5). Another tube, its lower end tied off with a string, was passed into the upper segment of the œsophagus for about five inches and left there to maintain patency. Five days after resection the wound was nicely granulating and a full-sized stomach tube passed through the mouth appeared in the wound.

About four days later a distinct, though slight, contraction was noted at the opening in the upper segment of the œsophagus. An Einhorn tube was placed in the stomach through the mouth, and through this the patient was fed for several weeks, milk, egg, and sugar being injected with a syringe.

January 12, 1921, I cocaineized the pedicle of the skin flap and divided it at the angle where the flap dipped into the chest. It was then dissected away from the inner part of the chest wall and turned over the œsophagus so as to form a

## CARCINOMA OF THORACIC OESOPHAGUS

rude tube (Fig. 6). It was hoped that the entire wound would now fill with granulations and that the case would soon be ended. The flap, however, proved to be most obstinate in its tendency to return to its normal position. During the next few weeks it had firmly adhered to the chest wall three times in spite of every effort to hold it in place with sutures and packing until finally I was forced to let it have its way for the time being.



FIG. 12.—Wound healed after plastic operation.

On January 26th, the granulations looked a little flabby and anti-syphilitic mixed treatment was begun. When the patient swallowed a glass of water about four drams of the six ounces entered the stomach.

February 8th, the mixed treatment had been followed by an improvement in the appearance of the wound. For the next few weeks the patient was fed entirely by mouth, the Einhorn tube having been removed and replaced by a large tube, forty-four calibre, which was passed through the wound into the openings in the oesophagus so as to bridge the gap and was kept from slipping into the stomach by a stout silk ligature which emerged at the margin of the wound and was strapped to the patient's back. Through this tube he was able to take fluids and semi-solids by mouth, and I hoped that when granulation should have closed the defect that the tube might be removed by way of the mouth through the oesophagoscope. Some days later, however, this tube became disarranged and the patient strangled and was distressed so that it had to be removed through the wound. The man was rapidly gaining in weight and his general appearance be-

came normal. His wound was packed with rubber dam several times a day which stopped the opening in the back so that he now took all his nourishment by mouth, liquids and semi-solids, with but little leakage, and I thought we were on the last lap of this trying surgical contest. It soon became evident, however, that obstruction at the end of the upper œsophageal segment was increasing and it was more and more difficult to pass bougies. Evidently, too, there was a tortuosity in the new œsophagus, and this was later demonstrated by the X-ray (Figs. 8, 9 and 11). Doctor Yankauer dilated the upper opening with the aid of the œsophagoscope, but the straight instrument could not be made to pass into the stomach. Meantime the external wound was allowed to close until only a small fistula, say about twelve French, persisted, the remainder having cicatrized firmly; but because of the increasing difficulty in passing bougies from the mouth to the stomach I felt that it would be necessary to reopen the wound, so, on March 31st, without anæsthesia, this was done. The new œsophageal lining was exposed by cutting through the posterior line of union which proved to be tough and cicatricial. It was with great reluctance that I sacrificed the skin union so long and anxiously awaited.

The cutaneous lining of the œsophagus was white and looked normal, although in the neighborhood of the external wound there was dermatitis and excoriation evidently from the presence of decomposing food. The finger in the wound detected the upper and lower œsophageal apertures, the lower easily admitting the index finger, the upper being much contracted. It is possible that this phenomenon might be accounted for by disturbance of the nerve supply to the lower segment. A silk string was swallowed by the patient and a tightly fitting rubber tube was drawn through the upper segment of the œsophagus and left there to stretch the stricture for twenty-four hours, a small stomach tube being inserted through the cardia for feeding. Although there was good dilatation by the tube, contraction again occurred in spite of the daily passage of instruments. The condition was enough to try one's patience to the utmost and I began to hear hints that a gastrostomy might simplify things. This it certainly would have done for it would have permitted the easy dilatation of the strictures with bougies tied to a swallowed string emerging at the gastrostomy wound. But I had set my heart on completing the case without opening the stomach. Finally, I was persuaded by Doctor Neuhof to reopen the wound and to expose the upper and lower orifices to inspection, dealing with them as might appear necessary. Accordingly I did this on April 28th, without general anæsthesia, but using a little cocaine locally. With retraction there was perfect exposure of the two apertures. Both had united nicely with the skin, but the upper was a mere slit with a tough cicatricial ring forming a collar about it. With a probe-pointed bistoury several radiating incisions were made until the largest sized bougie, about No. 50, could be passed without difficulty. The lower opening was treated in the same manner and for the same reason, although the contraction here had been slight. A piece of the contracted skin was removed for microscopic examination. It showed nothing remarkable.

The patient then began to pass a No. 45 stomach tube himself, and I felt the time had come to close the thoracic wound. On May 5th, I performed, in general anæsthesia, what I hope will be the final operation in this case. Thoroughly denuding the edges of the vertical wound in the new œsophagus, I closed it with interrupted chromic gut sutures, leaving a small opening below. I then dissected up the skin of the back, forming two flaps, one on each side of the wound, and sutured them together.

On May 11th, healing had so far proceeded that the patient swallowed liquids naturally and without losing a drop. Four times a day he passed a No. 45 stomach tube. He could take ordinary food made into a mash or after thorough



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mastication. The wound had healed soundly in the depths and there remained but two small flat granulating areas on the back where the flaps had been slid at the last operation. He was discharged otherwise apparently well on May 19th. It is intended that he shall pass the bougie several times a day for the greater part of a year or until there is reason to believe that the cicatrix will no longer contract. Davis F. was an ideal individual for pioneer work. If he was nervous he never showed it, and he coöperated in every possible way, enduring pain and great discomfort without complaint. Also, he evinced in a detached way keen interest in the outcome of his case.

The history of this case is that of my first completed operation of extra-pleural resection of the œsophagus without gastrostomy, and I believe it is the first in medical history. Four other patients upon whom I have made exploratory mediastinotomies for carcinoma of the œsophagus died and in every case the tumor had extended beyond the œsophagus. Three of the deaths were caused by infection of the mediastinum through injury to the diseased œsophagus while attempting to isolate it. In the fourth, that of Mrs. U., I have not been able to explain satisfactorily the operative death, although reference to the post-mortem notes will show that the case was inoperable. Abstracts of the four histories follow:

CASE I.—R. A., male, fifty-six years of age, entered Mt. Sinai Hospital, October 14, 1919. "For a number of months there had been vomiting and regurgitation of solid food immediately after swallowing until finally only water could be taken by mouth." The patient was cachectic and emaciated, with râles at both bases. The stomach tube was obstructed 45 cm. from the teeth. X-ray examination showed complete obstruction at the lower and middle thirds of the œsophagus. October 30, 1919, a Witzel's gastrostomy was performed by Doctor Neuhof. Specimen removed by Doctor Yankauer through œsophagus. Reported by Doctor Mandelbaum "squamous-cell carcinoma." Mediastinotomy was done on November 13, 1919, by me. Intratracheal anæsthesia by Doctor Branower. The long posterior eighth interspace incision was made and the eighth, ninth and tenth ribs were divided behind their angles. Owing probably to previous pleurisies there was complete obliteration of the left pleural sac by adhesions. This facilitated the operation. The flap of chest wall made by the incision just described was turned down and the aorta easily exposed for at least eight inches. The œsophagus was located with a bougie passed through the mouth and the tumor was easily reached. It was much larger than expected and was adherent to the pericardium and lower part of the left lung. The lower limit could not be ascertained because the growth seemed to pass through the diaphragmatic opening. The adherent lung was divided between ligatures and the œsophagus above the tumor was mobilized after cocainization of the vagus. Pus was encountered close to the tumor and the operation abandoned. The wound was closed with drainage posteriorly. No shock followed the procedure. Two days later the wound was dressed, the patient sitting up in bed without assistance. There was infection, however, from the suppurating tumor and death occurred four or five days after the operation. No autopsy.

CASE II.—John F., aged fifty-six, had had great difficulty in swallowing solids for only six weeks. When he was admitted to Mt. Sinai Hospital there was extreme emaciation and the X-ray showed œsophageal obstruction opposite the seventh dorsal vertebra with a filling defect extending downward for three inches and with dilatation above. There was inequality of the pupils but the

Wassermann test was negative. On June 24, 1920, Doctor Neuhof assisting, and Doctor Branower administering the anæsthetic by the intrapharyngeal method with ether, I operated. A long seventh interspace incision curved downward posteriorly over the eighth, ninth and tenth ribs. The eighth rib was resected subperiosteally and the ninth and tenth ribs divided posteriorly through the periosteum, the finger holding the pleura off from the ribs. The pleura was then further stripped away exposing the posterior mediastinum, but it was wounded in several places and not sutured. The exposure was excellent with the aid of the rib spreader and the neoplasm was easily found. There was an infected gland, and considerable time was spent in dissection. The tumor was firmly adherent to the aorta and the operation was discontinued. In dissecting the œsophagus with the stomach tube in place the musculature of the wall was injured so that the tube was clearly seen through the mucosa and eventually it was shown that infection took place here. The wound in the chest wall was closed by suture, the skin being left open. There was but little shock and two days later the patient swallowed fluids better than before, owing to the stretching of the œsophagus by the stomach tube. After that, however, general wound infection rapidly progressed and he died a few days later.

CASE III.—Samuel R., sixty-eight years of age, entered Mt. Sinai Hospital March 2, 1921. He had had "dropsy" thirteen years before. For two and a half months there had been regurgitation of food with difficulty in swallowing and with pain in the epigastrium and lower sternal regions. The patient was obviously old and emphysematous. The X-rays showed almost complete obstruction of the œsophagus near the stomach. March 3, 1921, gastrostomy was performed by Dr. Ira Cohen, Adjunct Surgeon. Pneumonia followed, although local anæsthesia had been employed. Then there was a double suppurative parotitis which finally yielded to massage. At last, on April 4, 1921, it was considered safe to perform the mediastinal operation. Nitrous oxide and ether anæsthesia. Because of the complete obstruction in this case continuous suction was carried out with a small-sized œsophageal tube which was inserted as far as the stricture. To make the suction more effective a dozen perforations were punched out of the wall of this tube. The object of this suction was to get rid of the fluids which might have entered the œsophagus, gradually filling it up to a point of overflow and causing aspiration pneumonia. The long flap was isolated, and the first steps of the operation were similar to those described in the successful case. The pleural cavity was unavoidably entered in several places, the operation proceeding, however, under intrapharyngeal insufflation. Two ribs above the ninth, and also the tenth rib, were divided posteriorly, the pleura being here easily stripped away. Working upward, now, I was surprised to see the entire posterior pleura as far as the mid-axillary line fall away from the costal and mediastinal chest wall. The pleura, however, was as fragile as wet tissue paper and was torn many times. The aorta and great splanchnic nerve were seen, the œsophagus palpated, and the tumor easily found. The upper limit was sharply marked about two inches above the diaphragm, but the lower limit was not reached, although it was believed to be above the diaphragm. While attempting to isolate the normal part of the œsophagus the right pleura was suddenly entered. There was a sound of rushing air, but the opening could not be seen. The heart's action became very irregular, the patient turned cyanotic, respirations were shallow, and at last it looked as though the man were dead. Thinking that the cardiac collapse was perhaps due to vagus disturbance, a pledget of cotton with five per cent. cocaine solution was placed for a few moments in the wound over the nerve and the wound in the chest fully closed. To my surprise the patient gradually recovered so that he left the table in good condition. About forty hours after the operation, however, he sank and died.

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The post-mortem inspection showed that the tumor had invaded the stomach, although that had not been ascertained at the time of gastrostomy. The right pleura had been entered and contained air and bloody serum. Death was apparently due to cardiac disturbance caused by pneumatic and circulatory changes in both chests. Pathological report of tumor by Doctor Mandlebaum was "adenocarcinoma with pearl formation."

CASE IV.—Mrs. L. U., forty-four years of age, had suffered from palpitation and dyspnoea on exertion for several years. She had also had an attack of œdema of the extremities seven months before I saw her. She entered Mt. Sinai Hospital on April 12, 1921, with a temperature of 101° F., pulse 84 and respirations 24. For six months there had been dysphagia and vomiting and loss of weight. There was much pain in the chest on deglutition. The patient was badly nourished and poorly developed. There were râles at the left apex with slight dullness. There appeared to be some cardiac enlargement with a systolic murmur at the apex. The spleen was palpable. The urine showed nothing abnormal. By the X-ray there was great narrowing of the œsophagus at the level of the seventh dorsal vertebra with a defect below. The patient could take the thick barium mass, but it passed through the stricture slowly. On April 13th, by œsophagoscopy, Doctor Kaempfer removed a tiny specimen which twenty-four hours later was reported by Doctor Mandlebaum as probably carcinoma, though the specimen was hardly sufficient for complete examination. Bleeding had greatly embarrassed the œsophagoscopy but Doctor Kaemper said that inspection strongly suggested carcinoma.

On April 14th operation was performed. Doctor Branower administered nitrous oxide and ether by the intrapharyngeal method and Doctor Neuhoef assisted at the wound. A perforated stomach tube with suction was used to keep the œsophagus free from secretion. The skin flap was made as in the first case, with its midline along the seventh rib, and about five inches of this rib were then resected subperiosteally and the pleura peeled away without injuring it. The sixth, fifth and fourth ribs were divided near the spine, and later the eighth rib as well. The great splanchnic nerve and the aorta were plainly visible. The tumor was found. Its upper limit was about one and a half inches below the aortic arch, but its lower limit was not palpable. No instrument could be passed through the stricture to facilitate the identification of the lower œsophagus. The upper part of the growth was firmly adherent to the aorta and it was peeled away with difficulty, this procedure being preceded by cocaineization of the vagus. It looked as if small portions of the tumor remained adherent to the aorta. Further dissection showed that the growth could not be freed from the pleura, so, fearing that I might wound the already eroded œsophagus, the operation was abandoned, though I hoped that it might be completed at some future time. The patient died, however, thirty-three hours after the operation, after a period of deep cyanosis with loud rattling in the trachea.

The post-mortem examination through the wound showed a large ulcerating carcinoma which had completely and widely perforated the œsophagus and was on the point of entering the pleura; indeed there were pleuritic adhesions here with a few flakes of fibrin and a minute quantity of turbid exudate.

From the experiences outlined in this paper, together with six other cases of transpleural exposure of the œsophagus with one recovery, a patient with œsophagospasm which was later dilated (*ANNALS OF SURGERY*, vol. 64, 1916, p. 94), I have reached the following conclusions:

1. That transpleural resection of the œsophagus has a forbidding mortality.

2. That fatal infection follows the primary opening of the œsophagus within the mediastinum.

3. That it is feasible to make an extrapleural exposure of the posterior mediastinum large enough to permit the operator to see clearly and to work safely with both hands in the wound.

4. That resection of the œsophagus in the posterior mediastinum can be done by dividing the operation into two stages. At the first the œsophagus is freed from its attachments and the mediastinum is sealed. At the second, ten to fourteen days later, the resection is performed.\*

5. This procedure deserves a fair trial by thoracic surgeons.

## OPERATIVE PROCEDURES AND SUGGESTIONS FROM THE LITERATURE

### DORSAL MEDIASTINOTOMY

NASILOFF (Vratch, 1888, No. 25) resected the third to sixth ribs on cadavers to expose the mediastinal portion of the œsophagus extrapleurally.

QUÉNU and HARTMANN, working on cadavers, did subperiosteal resection of portions of the third, fourth and fifth ribs.

POTARCA discusses which is the better side for approach.

BRYANT builds a quadrilateral flap. The middle rib of the flap is entirely resected. The other ribs temporarily resected. (Experimental only.)

OBALINSKI discusses the side of approach.

L. REHN builds a large skin and muscle flap from the spinous process of the third to ninth dorsal vertebræ. Resects several ribs.

VON HACKER discusses side approach, as also Bourienne.

*Note.*—The first experiments on animals were made by Nasiloff. After this a number of surgeons operated not only upon dogs and human cadavers, but also upon the *living human subject*.

REHN, LOBET, TUFFIER, FAURE, KÜTTNER also tried these methods, but none of their patients survived; all the operations were extrapleural.

### ŒSOPHAGOPLASTICS. (NOT RESECTIONS.)

WULLSTEIN, 1904, mobilized a piece of jejunum far enough under the skin of the thorax to complete an œsophago-jejunostomy with the upper end of the œsophagus. (An external plastic. No resection of the œsophagus.) *Deutsche med. Wochenschr.*, 1904, No. 20.

ROUX, 1907, œsophago-jejuno-gastrostomy. *Semaine Med.*, 1907, iv.

HERZEN employed a modified Roux method and reported a success. He shortened the path of the jejunum by a slit through the mesocolon and gastrocolic and omentum and brought the gut up through this to the subcutaneous chest. (Anterior.)

BIRCHER, 1894 and 1907, connected the œsophagus in the neck with the stomach though a tube made of cutaneous tissue, an œsophago-dermato-gastrostomy. A fistula formed, as was also observed by Payr in a similar operation. *Centralbl. f. Chir.*, 1907, No. 51.

ESSER, 1917, tunnelled a path in the subcutaneous tissue and used Thiersch grafts. The grafts were put around a glass tube. (No note of end results.)

KELLING, 1914, used the transverse colon. Œsophago-colo-gastrostomy. (Failure.) *Centralbl. f. Chir.*, 1913.

LEXER, 1911, combined various types. Œsophago-dermato-jejuno-gastrostomy, or œsophago-dermato-colo-gastrostomy.

\*The only patient whose case was operable and upon whom both steps of the operation could be done recovered. Case of Davis, F., page 4.

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HIRSH, 1911, used a pedicled flap made from the entire thickness of the anterior wall of the stomach.

JIANU, 1912, made a flap of the greater curvature of the stomach containing the left gastroepiploic artery.

REHN and RÖPKE proposed making use of the stomach plus the healthy distal stump of the œsophagus, after resecting it in the middle. (Modification of Jianu.)

First, v. FINK, then ENDERLEN and HOTZ, mobilized the stomach, closed the distal portion of the duodenum, did a gastroenterostomy; then brought the duodenal end of the stomach subcutaneously into the chest wall.

KIRSCHNER mobilized the entire stomach and brought it up into the anterior chest wall subcutaneously, making a gastrostomy opening in the chest, then connecting the stomach with the cervical portion of the œsophagus. (Kirschner's article reviews to 1920 the work in œsophagoplasty.)

HOFER and KOFLER, 1917, built a skin flap with its base at the vertebral column, and later made a tube of œsophagus. This work was done on the cadaver only.\*

BUDDE, 1921, built a tube of skin fascia and muscle around a glass rod; then implanted the tube between the cut ends of the œsophagus extrapleurally. This was done on the cadaver.

FAURE, LLOBET and TUFFIER all attempted to resect the œsophagus extrapleurally, but failed.

### OTHER PROCEDURES

JIANU-RÖPKE: Gastrostomie und Œsophagoplastik. Deutsche Ztschr. f. Chir., vol. cxviii, s. 383, 1912. A tube was fashioned from the greater curvature of the stomach but left attached at the fundus, this tube being brought up under the skin almost as high as the clavicle. An end-to-end anastomosis with the upper end of the œsophagus.

KIRSCHNER: Four cases. Two for stricture. One, an œsophago-gastroplasty for stricture, alive and well. The second, a stenosis of the œsophagus with lung abscess, died of lung complications and infection fourteen days after operation. There were two cases of carcinoma of œsophagus. The first, incision in the seventh left intercostal space. Intrapleural. Inoperable because of metastases. The second patient died of mediastinitis.

HALSTED: Jour. Exp. Med., 1909, 373-391. (Work on thoracic aorta.) Tracheotomy—insufflation of lung. Incision in seventh interspace. Rib spreader used.

ENDERLEN made a rectangular flap with its base to the spinal column from the spinous process of the third to the ninth dorsal vertebrae and extending to the mesial aspect of the scapula. All soft parts were divided down to the ribs and turned back. The periosteum was dissected away from the ribs, and pieces of rib, 10 cm. in length, were resected.

HENLE and ENDERLEN operated for removal of foreign bodies—dorsal mediastinotomy. Henle's patient died nine days post-operative. Enderlen's patient was discharged *cured after nine months*.

*Note.*—No surgeon operating for non-cancerous stricture of the œsophagus attempted resection. All made use of external œsophagogastrostomy or some other complicated procedure.

### SOME CONTRIBUTIONS TO THE SURGERY OF THE ŒSOPHAGUS AND POSTERIOR MEDIASTINUM

ACH: Beitrag zur Œsophagus Chirurgie. Verhandl. d. deutsche Gesell. f. Chir., 1913, vol. xlii, p. 260.

\* This suggestive work was unknown to me when I devised my operation. The periodical in which it was published (Münch. med. Woch., 1917, No. 34) is not yet available to me (H. L.).



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\* The four references with the asterisk practically cover this field.

## CERTAIN PROBLEMS CONCERNING FRACTURES OF BONE\*

BY CHARLES L. SCUDDER, M.D.

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OUR problems to-day have been the problems of the ages. Listen to what the wise Greek surgeon, Hippocrates, said in 400 B.C. in writing of fractures:

"I know physicians who have the reputation of being skilled in giving the proper positions to the arm in binding it up after fracture, while in reality they are only showing their ignorance. But many other things in our art are judged of in this manner, for people rather admire what is new, although they do not know whether it be proper or not, than what they are accustomed to, and know already to be proper; and what is strange, they prefer to what is obvious." "And," Hippocrates continues, "I must now state what the mistakes of medical men are, which I wish to unteach," etc.

Under the term *Fractures of Bone* I would eventually, when ideal conditions obtain, include the following:

- Fracture of the skull, protector of the brain;
- Fracture of the spine, so adequately shielding the cord from injury;
- Fracture of the thorax, with possible damage to the contained pleura, lung, and heart;
- Fracture of the pelvis, containing abdominal organs sometimes seriously damaged;
- Fracture of the long and short bones of the upper and lower extremities;
- Fracture of the articular surfaces of all joints;
- Gunshot fractures of the skeleton;
- Open or compound fractures, potentially infected wounds;
- All dislocations.

It will not be forgotten that associated with these fractures there may be contused and lacerated wounds and there may be sprains of joints, distant from the apparent injury. Shock may be present, slight or serious. In addition, damage to muscles, to single nerves or nerve plexuses, to tendons, and to important blood-vessels, may complicate the situation.

There are certain problems necessarily included in this group of injuries which are not altogether settled, viz.: (a) the process of repair of fractures; (b) the causes of ununited fractures; (c) the treatment of ununited fractures; (d) the repair of pathological fractures; (e) the proper handling of crushed fractures; (f) the treatment of malunited fractures.

This conception of the surgery of fractures, therefore, is seen to cover pretty completely traumatic surgery. A complete general surgical training and the ability to exercise that sound judgment which comes with experience is obviously necessary for the man who is to handle well the many difficult situations which may arise in any case. The task is a large one.

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\* Read before the American Surgical Association, June 14, 1921.

## PROBLEMS CONCERNING FRACTURES

*Fractures of the Long Bones.*—The older methods (rigid bone methods) of treating fractures: By "setting" the fractured bone; by the use of splints and plaster of Paris for fixing the "set bones"; by holding the joints immobilized above and below the fracture; by keeping tightly constricting and compressing splints and bandages on the fractured limb for weeks, the soft parts, the skin, nerves, vessels, and muscles all being left without care—these methods are abominable and should not be tolerated to-day. Good results under this ancient régime did occur—often obtained in spite of treatment, not because of it.

The principles underlying present methods of handling fractures of the long bones:

The French massage treatment advocated, practised, and taught in cases of fracture by Lucas Championnière and his pupils, notably Mennell in London.

The extension and counter-extension method advocated by Bardenheuer, of Cologne, and consistently followed by several English surgeons (notably Sir Robert Jones) and by American surgeons. Extension and counter-extension thus used requires careful supervision, a nice discrimination in its application, and permits supported active movements of the joints adjacent to the fractured bone at an early date and continuously throughout treatment.

The direct bony traction of Codivilla in Italy, of Steinman in Switzerland, of Ransohoff in America, bringing most effectively and accurately the forces of traction and counter-traction into action.

The direct grasp of a bone without penetration for the application of traction advocated by Hey-Groves and others.

The direct traction methods of Parkhill and Freeman in America.

The direct operative treatment advocated and popularized by Sir Arbuthnot Lane and others here and abroad.

The suspension of fractures—helping to eliminate muscular contraction and rendering more effective traction forces.

The use of the Röntgen ray.

All these principles and methods underlying fracture treatment have been recognized for years. Recently they have had renewed attention focused upon them by many surgeons because of the dire necessities of war. The treatment of war injuries tends to simplicity. Consequently many irrelevant forms of apparatus have been eliminated.

The war has further influenced the treatment of fractures by simplifying the emergency treatment; by an effective treatment of compound fractures (through the Carrel-Dakin principles); by eliminating certain inefficient traditional methods of treatment, and by emphasizing the possibilities of suspension and direct traction scarcely dreamed of a few years ago.

Experience, too, has gradually decreased the instances in which foreign unabsorbable material should be employed. The operative treatment is better defined in the selection of suitable cases. The selection of the appropriate non-operative treatment in individual cases can be more accurately made. The old principles of prolonged fixation of joints adjacent to fractures has

passed. The early active motion of joints under protection is employed and is furnishing remarkable results.

The results of the treatment of fractures of the long bones to-day are unusual compared with the results under the older methods.

General surgeons are as a group uninterested in treating fractures. There are, of course, exceptions in every community. The attention of the general surgeon has been directed from fractures to the more dramatic fields of abdominal surgery.

In general, the collective results of fracture treatment are even now throughout the country deplorably poor. The community, every fracture patient, the working man in particular, are all asking for better results. The employer of labor is demanding that injured men be gotten back to work more quickly, that fewer hours be lost. Great pressure is being brought to bear on the surgeon to secure more satisfactory results. The very large number of fracture cases occurring in any community makes the problem important. This demand for better functional results in a shorter time is a just demand. How shall this demand be met?

My answer is, briefly, the treatment of fractures may be improved—

1. By an organized fracture service in each of the large hospitals of the country;\*

(a) Special wards should be used for men, women, and children, and only fracture cases admitted. It is impossible to care adequately for these cases when they are scattered throughout the hospital. Responsibility is divided among many individuals. No concentrated interest results. Too much work is delegated to ignorant subordinates. The general service would be more free if separated from the fracture cases.

(b) A special fracture personnel should be in charge of these fracture wards. There should be a Chief of this service; a surgeon of broad general experience, whose interest should be active in moulding the policy of the fracture division. The Chief should have absolute control of the policy of the division. He alone should be finally responsible for results. Serving with and under this Chief should be the necessary assistant surgeons, resident house surgeons, and a nursing force. The service should be continuous throughout the year.

(c) This continuous control should include the Out-Patient Service, where the ambulatory cases are received and treated. Each day of the week there should be an Out-Patient clinic for fractures, which the Fracture Service controls and with which it is in intimate touch. The

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\*For a number of years there has been at the Massachusetts General Hospital, an organized Fracture Service. This is among the earliest, if not the first Fracture Service established in a general hospital.



## PROBLEMS CONCERNING FRACTURES

policies of the Out-Patient and House Fracture Services should be identical under the Chief of the service. Cases of fracture should be followed until the maximum functional results are obtained, and until the wage earner is on his feet and reestablished.

- (d) The emergency ward or accident service, in so far as fractures are concerned, should likewise be under the direct care of the Chief of the Fracture Service. A fracture received into the accident ward should be regarded as an emergency case requiring the immediate attention of those directly responsible for the ultimate result. A fracture should be considered as much an emergency as is a case of perforated gastric ulcer. The initial treatment is vital to a satisfactory outcome in both instances.
- (e) An operating plant in connection with the House Service is essential. The operative fractures must be kept apart from septic operations. Separate instruments must be employed.

- (f) A lecture room with easy access to the wards is necessary.

2. By adequate instruction of the undergraduate medical student. The student should have a definite concept of a fracture of bone: what it looks like, what it is, the changes taking place in the tissues involved, the processes of repair. All these conditions should be accurately visualized by the student. Then the principles underlying the treatment of a fracture will be more intelligently grasped, based upon known and familiar anatomical, physiological, and pathological facts. The undergraduate should be carried only a short distance in fracture instruction and only with illustrative cases.

Unfortunately, undergraduate medical students are overtaught today. The curriculum is crowded. The special branches should be taken from the routine curriculum and instruction limited more closely to general principles. This instruction in fractures should come in the third and fourth years. The medical school is the place to look for fundamental improvement in fracture treatment. Let us study to improve methods of elementary and graduate instruction in fractures. Good results are then bound to follow.

3. By instituting smaller hospital units in towns adjacent to and remote from large centres. An educational propaganda should be started which would result in a suitable fracture equipment being installed in each hospital. Such an equipment would afford opportunity for the instruction of certain interested physicians or surgeons of the community in the use of this equipment in actual cases of fracture. This educational propaganda might well be undertaken by individual surgeons of a large centre as definite educational missionary work.

4. By the graduate instruction of the general practitioner interested in fractures. The graduate medical school courses can readily supply this need. The details of treatment can here be covered very thoroughly.

5. Through the formal instruction of medical students intending to specialize in this branch of surgery. The infinite details of treatment

should not be taught to undergraduates, but should be taught the special undergraduate student in the graduate school courses.

6. By encouraging the specialization within general surgery of the surgery of fractures. Traumatic surgery to-day covers a complicated and varied field. I believe there is ample scope for such a specialty.

There will always be physicians in the community who will want to do everything, but there will also be some wishing to excel in a special field.

The establishing of a specialty of fracture surgery or of traumatic surgery in our larger centres should conduce to (a) better service to the community and (b) a more rapid advance in the knowledge of the treatment of special fractures.

At present in a large hospital it may be more practical for the neurological surgeon to care for head injuries and spinal injuries; for the thoracic surgeon to care for the pneumothorax following penetrating lung fractures of the ribs; for the genito-urinary surgeon to repair a ruptured bladder after fracture of the pelvis; for the abdominal surgeon to take care of the ruptured intestine in a crush of lower rib or pelvis; but the Chief of the Fracture Service should be a man so trained as to be able to handle any such complication that occurs in his division. Thus the special Fracture Service or Traumatic Service would occupy a dignified position along with the other special services.

7. By the organization of a Clinical Surgical Fracture Society meeting once a year for the sole discussion of fracture problems. The membership in such an organization should be carefully safeguarded.

Therefore, as Hey-Groves has put it, "by segregation of cases, continuity of service, and team work," by the properly organized instruction of the young men of the medical schools of the country working through special fracture services, by educational propaganda among the smaller towns, by carefully arranged graduate school instruction of medical practitioners, an influence may be gradually exerted which will eventually bring the results of fracture treatment to a high level, save dollars to the laboring man, save time to industry, and further the scientific investigation of problems connected with bone repair.

One query has grown out of this world war which is a very pertinent one and so widespread that it must be mentioned and answered. Orthopædic surgeons did splendid work during the late war. Only admiration is had for their early and complete organization; only praise for all they helped accomplish. Returning from the traumatic surgery of the war to civil life, the question is being forced upon surgical staffs of hospitals all over the United States and Canada. Shall fractures of bone and traumatic surgery as outlined above be delegated in the first instance to members of the orthopædic staff of our hospitals?

General practitioners of medicine must, of course, always take care of fractures to a greater or less extent, especially in rural communities. Such men should have opportunities to become familiar with good methods, espe-

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cially of first treatment afforded by graduate school courses. The general practitioner always has at hand some surgeon in a smaller or larger centre who should be competent in this kind of case. To him he will defer doubtful matters about any case. Fractures, traumatic surgery, should always remain a part of general surgery. No one should assume the care of fractures who is not fitted to meet properly the very serious complications, sequelæ, and attendant emergencies of fracture treatment.

Unfortunately, many good men are in orthopædic work who are not qualified as general surgeons. The opposition, I take it, that obtains on the part of the general surgeon to orthopædic men being assigned to the care of fractures rests solely upon the fact of their lack of general surgical experience. If in any community *competent* orthopædic men exist, of course they may properly be given the care of fractures.

My personal feeling is that the working out of this problem is to be a long and tedious one. We all want to see fractures and traumatic surgery better cared for. If the ground taken by the President of the American Orthopædic Association in his presidential address this year is realized, viz., "a most complete early training in general surgery of all those who would become orthopædic surgeons," then an improvement will have been made in one direction. The door to any special surgical work should be always through general surgery. Unfortunately many begin special work by short cuts which may definitely leave the stamp of narrowness and inefficiency upon the individual and his work.

Let the valuable special orthopædic training be conserved for the Fracture Service. Let us not make the mistake of immediately placing orthopædic men (yet untrained surgeons) at the head of special fracture services. Let us rather make the competent orthopædic men consultants to such fracture services under the present leadership of a Chief of Service—a general surgeon acutely skilled and interested in fractures and traumatic surgery. We then will preserve the proper relationship between the specialty of Traumatic Surgery or Fracture Surgery and General Surgery, and we shall gradually enrich this specialty by the brains of men interested in mechanical problems *per se*.

The time is coming when young men of this country will specialize in Traumatic Surgery. They will not be orthopædic surgeons doing traumatic surgery. They will be primarily Surgeons of Traumatism. The present scope of orthopædic surgery is sufficiently large to occupy the orthopædic surgeon. There are ample reasons for a definite specialty in Traumatic Surgery as outlined above.

## THE VALUES OF THE VARIOUS METHODS OF BONE GRAFTINGS JUDGED BY 1390 REPORTED CASES\*

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SURGEONS have been experimenting with bone graftings, and a sufficient number of the various methods have been performed to form a basis of their comparative values. All graftings reported in the literature, together with the results obtained from a questionnaire, have been analyzed.\* In these tables, methods are considered successful only when grafts have produced a satisfactory amount of new bone. Valuable conclusions can only be drawn from the results obtained by the employment of human bone, experiments in dogs being of little or no value in demonstrating either the best method of grafting or the reasons for the success or failure of the method employed. In dogs it is impossible to produce non-union of a fracture, except by interposing soft tissues. In the human, non-union of a fracture frequently occurs, and, while many are due to faulty treatment, a considerable number cannot be explained on any known hypothesis.

It seems true, with the possible exception of a few cells on the surface of a bone graft which are not cut off from their blood supply, that all the adult bone-cells in the interior of a bony transplant necessarily die because of their being cut off from their nutrient supply—that they never proliferate a new bone-cell. If this be correct, the objection to the use of the electric motor saw, on the ground that the generated heat kills the bone-cells, has no weight. The practical results of bone graftings show that there is little difference in the final success or failure of a bone graft whether it is made by a motor saw or a chisel. Too much importance has been placed upon the bone-cell as the essential element in bone regeneration, and this error has obscured a right conception of the process. Bancroft says: "Bone is mesoblastic in origin, and in its repair we find that calcium salts are deposited on the intracellular elements of connective tissue, forming new bone. The connective-tissue cell, then, by a process of metaplasia, becomes a bone-cell. Periosteum is a connective tissue and hence is prone to form bone, but it is not the *only* connective tissue that has this function." Neuhoff has performed some interesting as well as astonishing experiments in dogs. He transplanted fascia lata into defects made in the bladder, ureteral, and stomach walls, to see how connective tissue would act when introduced into these localities. To his astonishment, bone was formed in the fascial (*i.e.*, connective tissue) transplants in each of these three positions—that is, in a position where the transplants were each bathed in an acid fluid.

Since the tendency to the formation of connective tissue is universally

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\* Read before the American Surgical Association, June 14, 1921.

<sup>1</sup> Exclusive of Albee's statistics which are not available.

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present in the tissues, it seems reasonable to argue that there must be some peculiar chemical influence present in a particular location to cause the precipitation or deposition of calcium in connective tissue, in order to start the formation of bone. That acidity is not necessarily the determining factor in new bone formation, seems to be demonstrated in the formation of new bone in extraskeletal tissues, such as arteries, ovaries, kidneys, myositis ossificans, etc., where the alkaline blood bathes the tissues. Some chemical combination in the blood, in association with some local stimulus, rather than the reaction of the blood, seems necessary to form new bone in connective tissue. Perhaps some day the physiological chemist will discover some substance to inject into connective tissue which will precipitate calcium and start the process of forming new bone.

Connective tissue seems to be essential in the formation of bone. Osteoblasts are indistinguishable from fibroblasts. The first occurrence in bone formation is the arranging of fibroblasts (osteoblasts) around a blood-vessel. In this new fibrous tissue, calcium is deposited by some unknown influence, which goes on to the formation of bone. If calcium is deficient, fibrous union results, due to some chemical deficiency. If there is too much mobility between the fragments, there is a stage of cartilage formation which may eventually become changed into bone. Where there is no mobility, as in the fracture of one bone with a parallel bone acting as a splint, there is no formation of cartilage.

There are three requirements of a successful bone graft:

1. It must bridge a defect.
2. It must be of a size and type to reestablish the circulation.
3. It must act as a stimulus to osteogenesis. Raw living bone is a very powerful stimulus to osteogenesis. The osteoperitoneal method offers a very large area of raw bone, hence is to be preferred to all other methods of grafting.

There is much in osteogenesis that is still unknown, namely, the chemistry and the physiology of the process. Why is it that sometimes a bone graft, which has remained in place without suppuration, will gradually melt away in the tissues, will become gradually absorbed, and its place not be taken by new bone? This is one of the most disappointing results of a well-conceived and well-carried out bone-grafting procedure that can happen, and it has occurred to all of us. It makes no difference what method is employed in grafting; it occurs in all methods, whether the periosteum is on the graft or not.

### RESULTS OF REPORTED METHODS OF BONE GRAFTING

TABLE I.  
*Combined Statistics.*

Total Number of Cases, 1390. Successes, 1145, or 82.3 per cent. Failures, 245, or 17.6 per cent. With Periosteum, 1170: Successes, 970, or 82.9 per cent. Failures, 200, or 17.1 per cent. Without Periosteum, 196: Successes, 162, or 82.6



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per cent. Failures, 34, or 17.4 per cent. Suppuration in 121 cases, or 8 per cent., Successes, 32 per cent. Failures, 68 per cent.

TABLE II.

## Methods.

1. Bone pegs, 24: Successes, 23, or 95.8 per cent. Failures, 1, or 4.2 per cent.
2. Osteoperiosteal, 426 (Ollier, Codivilla, Delageniere): Successes, 372, or 87.3 per cent. Failures, 54, or 12.7 per cent.
3. End-to-end (without inlaying), 166: Successes, 137, or 82.5 per cent. Failures, 29, or 17.5 per cent. With periosteum, 74: Successes, 54, or 72.9 per cent. Failures, 20, or 27.1 per cent. Without periosteum, 92: Successes, 83, or 90.2 per cent. Failures, 9, or 9.8 per cent.
4. Inlay, 540: Successes, 437, or 80.9 per cent. Failures, 103, or 19.1 per cent. With periosteum, 494: Successes, 396, or 80.1 per cent. Failures, 98, or 19.9 per cent. Without Periosteum, 46; Success, 41, or 89.1 per cent. Failures 5, or 10.9 per cent.
5. Intramedullary (Murphy), 214: Successes, 164, or 76.6 per cent. Failures, 50, or 23.3 per cent. With Periosteum, 140: Successes, 117, or 83.5 per cent. Failures, 23, or 16.5 per cent. Without Periosteum, 64: Successes, 45, or 70.3 per cent. Failures, 19, or 29.7 per cent.
6. Combined Intramedullar (one end) with Inlay (other end), 20: Successes, 12, or 60 per cent. Failures, 8, or 40 per cent.

Table I shows a total of 1390 patients upon whom bone graftings were performed, and of these 1145, or 82.3 per cent., succeeded, while 245, or 17.6 per cent., failed. Successes were the same proportionately whether periosteum was on the graft or not. Analyses of the various methods show that 95.8 per cent. of bone pegs were successful, these being, of course, without periosteum or endosteum upon the grafts. The osteoperiosteal method, developed by the French school, particularly Delageniere,\* proved the next most successful. This consists in moulding about the fragments strips of periosteum, taken from the tibia, to which adhere thin plaques of bone. Successes by this method were 87.3 per cent. By the end-to-end without inlaying method, favored by the English surgeons, 82.5 per cent. of successes were obtained, and by the inlay method, most in favor in America, 80.9 per cent. were successful. By the intramedullary method, developed by Murphy, only 76.6 per cent. of successes resulted. The intramedullary graft at one end combined with an inlay at the other, with 60 per cent. of successes, proved the least successful of all, possibly because of the liability to dislocation of the graft. This would tend to show that the intramedullary method should be discarded as a method of bone grafting.

Further analysis of the effect the presence or absence of the periosteum has upon the results of the various methods of bone grafting shows the following (Table 2):

3. End-to-end, With Periosteum: Successes, 73 per cent. Without Periosteum: Successes, 90 per cent.
4. Inlay, With Periosteum: Successes, 80 per cent. Without Periosteum: Successes, 89 per cent.

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\* Jour. de Chir., vol. xvii, April, 1921, p. 305.

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5. Intramedullary, With Periosteum: Successes, 83.5 per cent. Without Periosteum: Successes, 70.3 per cent.

Thus, with the end-to-end method there were 18 per cent. *fewer* successes and with the inlay there were 9 per cent. *fewer* successes with grafts *with* periosteum than *without*, while with the intramedullary method there were 13 per cent. *more* successes with grafts *with* periosteum than *without*, so that we must draw the conclusion that in the end-to-end and inlay methods, periosteum on the grafts seems to be slightly disadvantageous, while on the intramedullary grafts it acts more advantageously with than without. Ashhurst has reported 27 inlay bone graftings without periosteum with 22 successes (81.5 per cent.), and Gallie, 18 inlays without periosteum, with 100 per cent. of successes. It is difficult from these statistics to measure accurately the value of periosteum on grafts. Theoretically, most surgeons believe it of value: though not considered essential, it is supposed to assist in establishing a new and richer circulation, upon the extent of which the amount of the formation of new bone seems to depend. Several reasons may be advanced to account for the relatively poor results of intramedullary grafts. Firstly, because of the obliteration of the nutrient artery, from which the graft largely obtains its blood supply, through thrombosis, antecedent trauma or operative procedure. Secondly, because of the liability of dislocation of the graft. Thirdly, because of its susceptibility to fracture. Fourthly, because of the difficulty of adequately immobilizing or anchoring the graft. Fifthly, because, in the opinion of some, of the lack of periosteum. In case of suppuration the success of the transplantation has been deemed more likely *with* periosteum than *without*, for the periosteum is much more resistant to infection than bone. In illustration of this fact, I reported (ANNALS OF SURGERY, 1921) one case of an inlay graft with periosteum, made for a defect in the lower jaw, which suppurated, losing, by sequestration, almost its entire bone content, which eventually proved completely successful through the re-formation of the bony segment, which presumably came from the transplanted periosteum.

Fisher (*Lancet*, April 23, 1921, p. 844) says:

"From a study of the pathological appearances in the cases of loose bodies of bone and cartilage quite free in the joint, it is clear that the majority of the bone corpuscles were dead, as exemplified by lacunæ no longer holding stainable cells. Furthermore, in not a single case was there any evidence of proliferation of osteoblasts with formation of new bone. Yet we see a striking difference on examining those bodies of traumatic origin and containing bone which have acquired an early adhesion to the synovial membrane. For in these, fresh capillaries can be seen to have penetrated the cancellous spaces, and active proliferation of osteoblasts with formation of new bone is taking place. Exactly the same thing can be observed in the experimental production of loose bodies which show secondary attachment to the synovial membrane with active proliferation of bone cells. These observations therefore support Hey-Grove's contention that the osteogenetic cells in the Haversian canals and cancellous spaces of an autogenous bone-graft actively proliferate only if the graft becomes to some extent vascularized by the ingrowth of capillaries from sur-

rounding parts. As, therefore, the vascular supply appears to be of such paramount importance in the osteogenic function of the bone-graft, it would appear to be advantageous to retain the periosteum in order to enable the graft to establish its vascular connections as rapidly as possible."

The part played by periosteum has been considered by Leriche and Policard: It seems to them that periosteum has two elements with antagonistic tendencies, but the juxtaposition of these two elements produces a harmony in the process of osteogenesis. The element of bone growth is in the cambium layer of the periosteum (i.e., the juxtaosseous connective tissue) and the adjacent bone, and that which arrests bone formation is the outer fibrous layer of the periosteum. Between the two there is normally a state of equilibrium and leads to the entire series of osteogenesis, hence the periosteum is the whole manageable agent of surgical osteogenesis. By the stripping up of the periosteum, the cortical layer of the bone regains its power of extension, new bone appears, pushed forward to establish a new state of equilibrium. This view seems to be substantiated by the results of subperiosteal resection of bony prominences, in which new bone is formed beneath the periosteum, not outside of it unless the periosteum has been ruptured. Renfrew White says: The osteogenic properties of the periosteum, which it seems to possess, are, in fact, not its own but due to a resumption of osteoblastic activity of the cells of minute portions of bone that have adhered to it, having been detached with it.

Sebilleau (*Presse Méd.*, August 1, 1918) showed a specimen, removed at autopsy ten months after an osteoperiosteal graft, four inches long, taken from the tibia, which had been transplanted to bridge a defect in the lower jaw. There was a firm osseous callus between the two stumps, although the outer periosteal surface had been turned, being directly applied to the bone surfaces, reversing the ordinary procedure. This seems to show that a graft is endowed with vitality in itself.

A study of these results of the various methods of bone grafting shows definitely that the method most likely to achieve success is the osteoperiosteal. That this method is applicable in large defects is shown in a case reported by Katzenstein (*Rev. de Chir.*, May, 1910, p. 952), where 13 cm. of the diaphysis of the femur were missing. He hollowed out, in the end of each fragment, a cavity which received the extremities of the transposed periosteal strip to which were clinging thin plaques of bone of the thickness of a dime. Immobilization was maintained for six months, when the defect became filled in with new bone, and the man could walk without support. An advantageous amplification of this method would be, after removing the periosteal strips from the tibia, to take bone chips from the raw tibial surface with a gouge and to implant these chips so as to fill in the defect (Macewen) between the ends of the fragments. The osteoperiosteal flaps overlap the ends of the fragments to which they are sutured with catgut. The advantages of this method include:

1. Increased liability to success of the grafting.
2. Greater simplicity of the technic of obtaining the graft, there being no necessity of complicated motor saws.
3. Decrease in the liability of subsequent fracturing of the tibia from which the graft is taken, of which there are numerous reports in the literature.

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Macewen has recorded successes after implanting small bone chips in the human while Bancroft has had successes with the same method. A much better method than to fill a bone cavity with fat after sterilization, is to fill the cavity with a curled-up osteoperiosteal flap. By this procedure the cavity becomes filled with new bone.

### CAUSES OF FAILURES OF BONE GRAFTINGS

1. *Improper Method Employed.*—From Table 2, it is seen that the osteoperiosteal method is attended with the greatest number of successes, and the intramedullary method with the smallest number. The presence or absence of periosteum seems to be immaterial.

2. *Suppuration.*—This is apparently the most evident cause of failures in bone graftings. Walker (ANNALS OF SURGERY, January, 1921, p. 2) reports that in 62 per cent. of 46 cases in the army (Surgeon General's Statistics) which suppurred after graftings, the transplants were finally successful. These results are clearly too favorable, because in the author's statistics of 1390 graftings, successes were 82 per cent., hence Walker's statistics show only 20 per cent. injuriously affected by suppuration. Of the author's reported 121 cases (8 per cent. of all), which suppurred, only 32 per cent. were successful.

3. *Immobilization.*—Insufficient immobilization, or over too short a period, seems to be a very patent and frequent cause of failures. The most perfect immobilization that can be obtained after graftings should be employed. Brooks has shown that the absorption of bone in a bone graft is not complete before the end of two months. In addition regeneration of bone, as a result of a bone graft, depends primarily upon the blood supply to the graft. These new-formed blood-vessels are very easily ruptured by mobility of the fragments, thus compromising the necessary blood supply to the graft. Hence the suspension method of treating bone grafts in a Balkan frame is contra-indicated as allowing too much mobility between the fragments and the graft. Massage is likewise contra-indicated for the same reason. From four to six months absolute immobilization is the minimum time in which it should be employed, unless careful testing shows consolidation to be complete before this time.

4. *Fracture and Dislocation of the Grafts.*—These likewise are often the cause of failures and are frequently due to insufficient immobilization.

5. *Atrophy of the Ends of the Bone Fragments.*—No grafting should be undertaken if a radiogram shows the ends of the bones to be markedly atrophied, which is caused by deficient nutrition from too tight or too long prolonged immobilization, suppuration, neurotrophic disturbances, senility, etc. In such cases measures should be taken before grafting is undertaken to stimulate the function and the circulation of the parts by removing all splints, allowing free use of limb, bakings, massage, Bier's hyperæmia, etc.

6. There is no evident explanation of some failures of bone grafting. Despite aseptic healing in of the grafts, a certain proportion of them (17.6 per cent.) will fail, indicating some chemical or physiological deficiency, of which we are as yet ignorant. Greater efforts in future must be made along chemical and physiological grounds to discover the elements which initiate new bone formation as well as those which continue the process when once it has started.

#### CONCLUSIONS

From 1390 bone graftings we find:

1. That there were 82.3 per cent. of successes with 17.6 per cent. of failures.

2. In the order of successes, we have,

a. With bone pegs, 95.8 per cent. were successful.

b. With the osteoperiosteal method (Delageniere), 87.3 per cent. were successful.

c. With the end-to-end method (without inlaying), 82.5 per cent. were successful.

d. With the inlay method, 80.9 per cent. were successful.

e. With the intramedullary method (Murphy), 76.6 per cent. were successful.

f. With the combined intramedullary (at one end) and the inlay (at the other), 60 per cent. were successful.

3. The presence or absence of periosteum seems to exert no influence on the success of bone grafts. Proportionately, the percentage of successes without periosteum (82.3 per cent.) is the same as with (82.9 per cent.). In the end-to-end method, there were 18 per cent. more successes than failures without periosteum, and in the inlay method, 9 per cent. more successes without periosteum than with, while, on the contrary, with the intramedullary method, there were 13 per cent. more successes with grafts *with* periosteum than without. It is difficult to explain the cause of the differences in the various methods.

4. Suppuration occurred in 121 cases, or 8 per cent.; 32 per cent. of these succeeded. Suppuration is the most frequent cause of non-success of graftings, with insufficient immobilization and too short duration as the second most frequent cause.

5. The conclusion is reached that the most successful method of bone grafting is by the osteoperiosteal method (Delageniere). The bony defect should be filled in with small bone chips, and on one or two aspects, overlapping the ends of the fragments, covering in the bone chips, should be placed one or two strips of periosteum with adherent, osseous plaques, taken from another bone. This method is as applicable to large as to small bony defects.



## BONE GRAFTINGS

6. The cause of many non-successes is due to defective immobilization, or to undue curtailment of its duration. From four to six months' immobilization is ordinarily required for complete success.

7. There is sufficient evidence to prove that the most effectual treatment of non-union of fractures is bone grafting.

8. The causes of failures of bone graftings, summarized, are:

- a.* Improper method of grafting.
- b.* Suppuration.
- c.* Insufficient immobilization, or over too short a period of time.
- d.* Fracture and dislocation of the grafts.
- e.* Atrophy of the ends of the bone to be grafted.

9. The intramedullary method of grafting should be discarded.

10. Despite a few opinions to the contrary, bone graftings should not be performed in infected fields.



## OLD OS CALCIS FRACTURES\*

BY FRED J. COTTON, M. D.

OF BOSTON, MASS.

OS CALCIS *fractures*, not common, scarcely seen except as the result of industrial accidents, are of interest because they give so large a percentage of cripples and because these cripples are strong men as a rule in youth or vigorous middle age.

Years ago<sup>1</sup> I went into the question of the treatment of the fresh os calcis fractures, basing recommendations on a serious investigation of a long series of old cases at the City Hospital, and on a recognition, by us apparently for the first time, of the essentials of the injury and the real *causes* of disability.

Neither in the cases in this paper nor in those of a later one<sup>2</sup> nor in the cases collected by the Industrial Accident Board of Massachusetts<sup>3</sup> have we acquired data on which to base any accurate percentage statement of disability.

There are, under ordinary treatment, a few cases (without much original displacement) that recover with good or fair feet; these are cases mainly of little displacement; a large proportion, certainly much more than half the total, are partly disabled and handicapped in their work: total disability for real work seems to be the fate of something like one-third to one-half the cases.

There is, I think, nothing to add to what I have already written as to fresh cases in the above-cited articles and in a book<sup>4</sup> on fractures, as to lesions or treatment, save for the addition of later cases. Today I should perhaps lay more stress on remodelling, less on "impaction," for I suspect that the impaction resulting is not mechanically first-rate as a rule.

This remodelling or impaction method has been adopted by a good many surgeons with good results, I think, as a rule. My own cases have been not perfect, of course, but satisfactory, and I think there have been none with serious permanent disability. But, while I see fewer fresh cases each year,<sup>5</sup> on the other hand I see, of late, more and more a number of the cripples untreated very often diagnosed as sprained ankles in the early weeks. These men, disabled, out of work in several instances for a year or two years, have been referred to me by insurers as a rule, with the idea of returning them to industry. They have usually been baked and massaged with no benefit (except to the baker), the "bakee," if one may so call him, still limps, and keeps on with his compensation under the accident laws. The problem is not new, or easy. My earlier attempts were rewarded by improvement, not by cures.

I had worked with the idea of clearing away excess bone, on the outer side, removing spurs, and limbering up joints by manipulation.

Prince, of Rochester, N. Y., had done arthrodesis of the posterior calcaneo-

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\* Read before the American Surgical Association, June 14, 1921.

## OLD OS CALCIS FRACTURES

astragaloid joint to relieve strain. No one else seems to have done anything in particular.

In the last two years I have been beginning to get real results—good enough to feel that we have something approaching a solution of the problem. Wherefore, this paper was prepared.

The cases run curiously similar as a rule in their main features. In the



FIG. 1.

first place, they all have the calcis a little short from front to back, a bit flattened, often more than a bit, on the sole. Beyond a little loss of "spring," this shortening seems to make little difference. Rarely there is sharp *outward deviation* of the whole heel. This entails inevitable flat-foot, not to be relieved by supports. The deformity must be corrected by the Gleich operation, of which more later.

Third: Spurs on the plantar face of the calcis are not uncommon. If tender, as they usually are, they must come out.

Fourth: In every crippled case that I have seen, the outward broadening due to the shoving outward of the peroneal plate of bone and to bone-growth behind it, has been a source of trouble. Sometimes the external malleolus hits the exuberant bone or is half buried in it: sometimes it hits only in extension

or only in flexion: sometimes it merely pinches the peroneal tendons and their sheath; but, invariably it is a factor in the pain and disability.<sup>6</sup>

How considerable this mass often is will be seen from some of the X-rays taken from above and behind—a rather useful even if an unusual view.

Fifth: The loss of some part of the lateral motion is constant; loss of *all* lateral motion not rare. As a rule, this limited motion is, at its limits, painful, and is always a bit disabling because of resultant clumsiness. This loss of motion results from what we may call clogging of the posterior calcaneo-astragaloid joint either from fracture across it or from fracture displacing the unbroken joint-surfaces or shortening the slide; or from new bone heaped up roundabout the malleolus or in front. Practically all motions of the foot laterally, remember, depend on free motion in the two joints on the under surface of the astragalus, both joints articulating with the os calcis. With

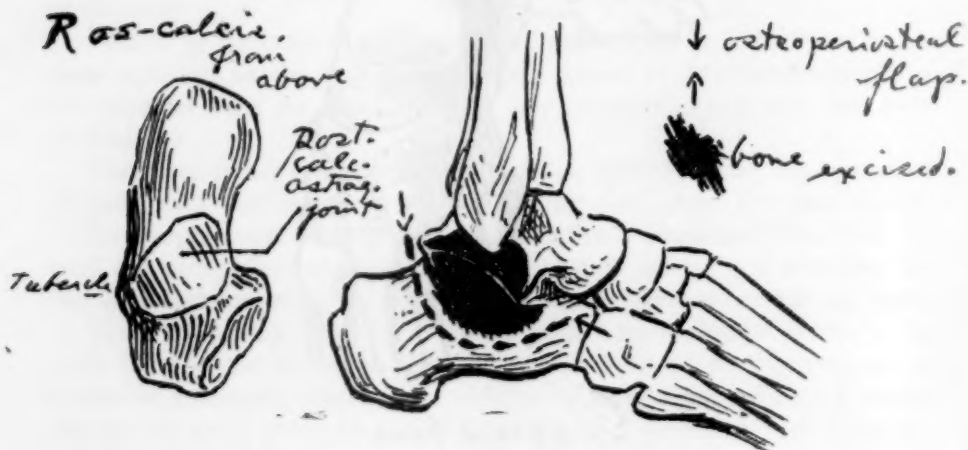


FIG. 2.

even only the posterior joint locked, the lateral mobility of the foot is gone.

Now, as to the repair of these various "proximate causes of disability."

*First:* Shortened and flattened heel; not to be touched, save when combined with outward displacement. *Second:* Outward deviation; calls for the "Gleich" operation, an operation devised for the cure of flat-foot—a cross-section of the calcis done behind the posterior joint of the os calcis with the astragalus. The original description specified a Gigli saw—I have preferred a thin chisel, cutting on a slant slightly down and forward, forward and inward. The calcis so cut, it is then easy to displace the heel as one will—with ragged chiselled surfaces, no other fixation than the plaster is needed. This operation I have done twice; it is a perfectly simple and straightforward manœuvre. *Third:* Spurs; sometimes they are spurs of an original fragment, sometimes perhaps newly grown. They are to be removed, just like the common osteophytic spurs, through an incision at the side, well above the thick skin of the heel, and they are to be removed very liberally, as are *all* os calcis spurs. *Fourth and Fifth:* These are in fact *one* problem. The

## OLD OS CALCIS FRACTURES

fracture is a crushing fracture with irregular cleavage lines. The result of the usual treatment advocated, which is by way of being no treatment at all, is the formation of a broad, shapeless bone, which has lost all chance of rocking under the astragalus, which has spread so far out and up under the outer malleolus as to give crippling pain from bone contact beside the loss of motion. The failure of a good many attempts to remedy this, including my own earlier efforts, was due to our failure to appreciate the mass of this bone growth, and its great total bulk, and to take account of the fact, well enough known really, that the tarsal bones repair their injuries with unusually

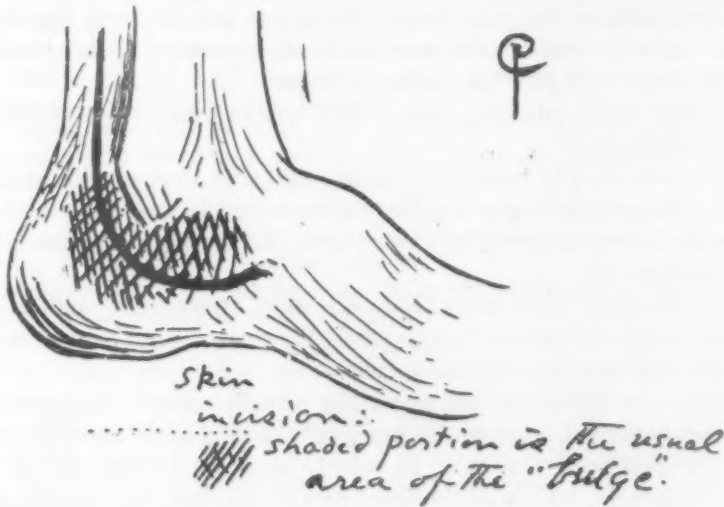


FIG. 3.

massive bone replacement.<sup>7</sup> One must do far more than at first seems reasonable.

The key to this whole question is the doing of enough surgery. It is like the man who "shaves a day ahead"; one must do much more than to remove the presenting excess of bone. Latterly, I have doubled the bone removed, have dug out deep and wide under the peroneal tendons, and then laid them back under pressure. More than that, I have cut ruthlessly across the joint line between astragalus and calcis, often leaving what seems not half the joint.

The operation, as developed, is a skin incision, curved down and forward beneath the external malleolus—a stripping up and laying forward and upward of a flap, including the peroneal tendons in their sheath, turning up with them the periosteum and with it the cortical layer of bone; then comes a thorough clearing away of all the excess bone, deep below the cortical level, leaving a saucer-line crater of bone. In doing this clearing away one cuts across the posterior astragalo-calcaneal joint regardless of ligaments and of joint capsule. (See Fig. 2.) Then, forced manipulation in rotation and in abduction and adduction of the foot complete the clearing of any obstacle to

motion from bone, from adhesions or from scar. At this stage, after reduction, motion should be near normal and unimpeded by adhesions or by excess bone. After the clearing away of excess bone the periosteal bone flap, carrying the tendons, is laid down into the crater from which the discarded bone was removed. Loose suturing completes the open operation.

Plaster is applied in neutral position, and without regard for right-angled flexion. One has never to fear loss of ankle-joint motion in these cases; it simply does not happen; and I have long preferred a position of moderate plantar flexion to the alternative of tenotomy of the T. Achilles, which not uncommonly leads to a rather long-continued atrophy of the calf muscles.<sup>8</sup>

Pressure from outside is applied to the case to keep the deep flap in place under the malleolus in the crater provided by the operation. After two weeks the plaster is cut and guarded motion is begun.

After four weeks one may allow a little weight bearing—cautiously, and motion is emphasized.

At six weeks weight-bearing is allowed; still with some caution, gradually increasing the weight borne, steadily emphasizing the regaining of motion by voluntary exercise, aided by stretching in the hands of the masseuse in case of the laggards.

In the less likely cases arch plates are used, temporarily—either of the usual type, or of the "rocker" plate (the "Whitman" sort)—worn until the foot comes back to useful function.

For the cases so treated, one may claim actually normal function in one; approximately normal, one may say practically normal in six more of the total of nine operated on.<sup>7</sup> One case, an elderly man, not robust, still has some arthritis tenderness, mainly of the front part of the foot, that interferes a bit with his work.

One case I write down a failure—probably because no one here understands Russian, and he speaks only Russian of some sort. Therefore the routine of exercises could not be impressed on him effectively. Perhaps we mistook his smile for comprehension. I suspect he, too, will later return to work, but for the moment he is written down a failure. The others are cured. Of the two treated as fresh lesions, both are at work, near normal in function. Three, not operated on, have come back to near normal under persistent treatment. Two are too recent to report on.

The case records follow:

CASE I.—T. McN., aged thirty-six. Carpenter's helper.

Accident: October 24, 1917, fell squarely on both feet. Eleven weeks in bed. One month on crutches; then two canes; able to walk without canes about March, 1918. Referred by London Guarantee and Accident Company, Limited (Figs. 2 and 3).

Pain and weakness about ankle of right foot. Marked disability.

Left foot showed on examination by F. J. C., June 10, 1919, a "rigid flat-foot" not of extreme degree, nothing else.

Right foot showed "very evident os calcis fracture with marked thickening below the external malleolus, with definite broadening of the heel seen from be-



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hind with a spur on *both* sides so large as to be easily felt with the fingers. The foot not much flattened and the heel is *not* turned outward. No lateral motion. Fair ankle motion." This man has had a fracture of the right os calcis with marked spur projection into the sole. This is the tender point. There is also some tenderness below the outer malleolus and some soreness running down the foot from this point. No swelling. The general condition and ability to use this foot have become, under much massage, much better than one would expect from such findings.

Operation proposed to clear the spur and to remove excess bone on the outer side.

It is worth noting that an astragalectomy operation had been advised on this case less than a month before I saw him. One is at a loss to see how an astragalectomy could help; certainly it would cripple! I have yet to see a really good working result after astragalectomy—and I have seen not a few.

June 3, 1919, the usual operation was done, including also in this case the removal of a sharp spur. (See Fig. 3.)

Convalescence was as usual, but slow, which is hardly unusual. It was necessary to fuss with a plate for a time, with anterior arch pads also.<sup>20</sup> He also complained of toe-contractions for a time.

Some time (I have not the date) early in 1920, he went back to and has stayed back at work, with serviceable recovery. Disability before operation one year eight months. After operation, under nine months.

Moreover, this result was impeded a bit by the spastic flat-foot on the other side—treated, but yielding to treatment slowly.

The foot operated on showed the usual return of well over half the lateral mobility. There was entire, though slow, cure of the sensitiveness from spur pressure.

CASE II.—T. McN., aged thirty-three. Lineman.

May 25, 1918, fell fifteen feet, landing on left heel. Other foot unhurt. No ether for reduction or pseudoreduction. "Cast" for seven weeks. Crutches up to about June, 1919. Referred by the London Guarantee and Accident Company, Limited.

Seen by F. J. C., August 6, 1919. Previous to this I had had sent to me plates of both his feet, showing, besides the deformity in one, an appalling "traumatic arthritis" picture of osteoporosis in both feet. Examination of the feet themselves, not hot or tender or swollen or spastic, made it evident that this was a result not of an essential arthritic process, but of the fifteen months of utter disuse. Examination showed on the right only an old flat-foot, strained from having more than its share of labor imposed on it.

"The left foot, on the other hand, shows a condition which I think will have to be remedied by operation. The os calcis has been fractured and there has been marked displacement of the back portion of the bone (which includes the bearing surface of the heel) outward rather than upward. The flattening of the foot by bone displacement is less than usual, the thickening of the foot no more than average in these cases, but this outward displacement is very extreme and I think without question that it is too great to be remedied effectively without an operation."

The operation proposed was the Gleich operation, namely, a section of the astragalus behind the inner vessels and tendons, down and in, forward and inward.

This was done October 27, 1919, and with the Gleich operation the excess bone below the external malleolus was removed in the usual fashion (Fig. 4). He was in the hospital for just a month. There was the usual slow recovery and gradually increasing use. At about a year<sup>21</sup> he went back to work, and, according to a friend he referred to me lately, is still at work.

## FRED J. COTTON

Disability, original, before operation, seventeen months. After operation, not quite a year. Result almost 100 per cent.

CASE III.—W. T., aged twenty-one years. Sprinkler fitter's helper.

On November 14, 1918, fell forty feet. Treated at City Hospital, and about January, 1919, came under treatment of Dr. A. T. Cornwall. Seen by F. J. C., May 26, 1919, for the Accident Board. Reported as a result better than usual, but with broadening and much thickening of bone on the outer side. Lateral motion much better than usual, but some pain on the outer side in even moderate pronation. Trouble only occasionally, but it involves an uncertainty that bars him from liability to accident. Sent by the U. S. Casualty Company for operation.

Operation August, 1919. The usual operation. He did well, but slowly. Motion excellent and no longer any "catching" on the outer side. He was fitted to a plate with relief and complained only of occasional pain down the outer side of the foot. The foot is practically normal in appearance and nearly normal in motion. He worked a month in the fall of 1921. Later complained of contracted "hammer toes" and was given treatment to stretch them. Redischarged as practically normal in February, 1921.

This is in fact a perfectly good cure. Personal disinclination and an unfavorable labor market just now are the key to the persistent disability.

CASE IV.—A. F. G., aged forty-one.

Accident July 21, 1919. Fracture R. os calcis; treatment persisted in without much improvement. Seen by F. J. C., May 21, 1920; referred by the U. S. Mutual Liability Insurance Company. He showed the usual picture with *total* loss of lateral mobility, with much pain from apparent contact of malleolus and calcis—and also—unusual inability to come up on his toes because of contact of the malleolus with a mass of thickened bone far back (Fig. 6).

He was particularly annoyed because as sole survivor of a gun-squad of the Cameronian Highlanders, and shot-up at that, he felt it beneath his dignity to succumb to so unexciting a lesion.

Operation June 1, 1920. The usual operation but with a very liberal removal of bone. In hospital twelve days. Plates and massage as usual. Last seen September 23, 1920, at which time there was still some broadening but almost full mobility. He then demonstrated his ability to jump up in air and crack his heels together twice—not equal to his previous normal of three times, but fair enough. He then went back on his job, and so far as I know is still there.

CASE V.—F. McJ. Accident September 9, 1919. Fell thirty to forty feet on his heels. City Hospital. Plaster six weeks; later electrical treatment with Dr. Frank Gardner. Report of examination April 23, 1920, showed typical condition, thickening pain on standing or walking, etc. Further treatment instituted. Seen by F. J. C. Referred by Maryland Casualty Company. Usual flattening, broadening, thickening to the outer side, loss of most of the lateral motion (Fig. 7).

Operation September 27, 1920. Treatment and recovery as usual.

Improved rather quickly but showed some tendency to pronate; relieved by plates and by juggling the shoes. Last seen April, 1921. No evidence of disability at all, though lateral motion not to full normal limits.

CASE VI.—B. O., window washer. Accident November 8, 1919. Fell two stories. Referred by Dr. Frank Gardner for the Maryland Casualty Company. Seen by F. J. C., August 20, 1920. Showed clear evidence of double os calcis fracture with little displacement, not much thickening, and good motion on the right.

On the left extreme thickening "choking up" against the fibula, not only laterally, but also at the front, with almost no lateral motion. Disability to correspond.

Operation August 30, 1920. Usual technic. Hospital one month, no sepsis,

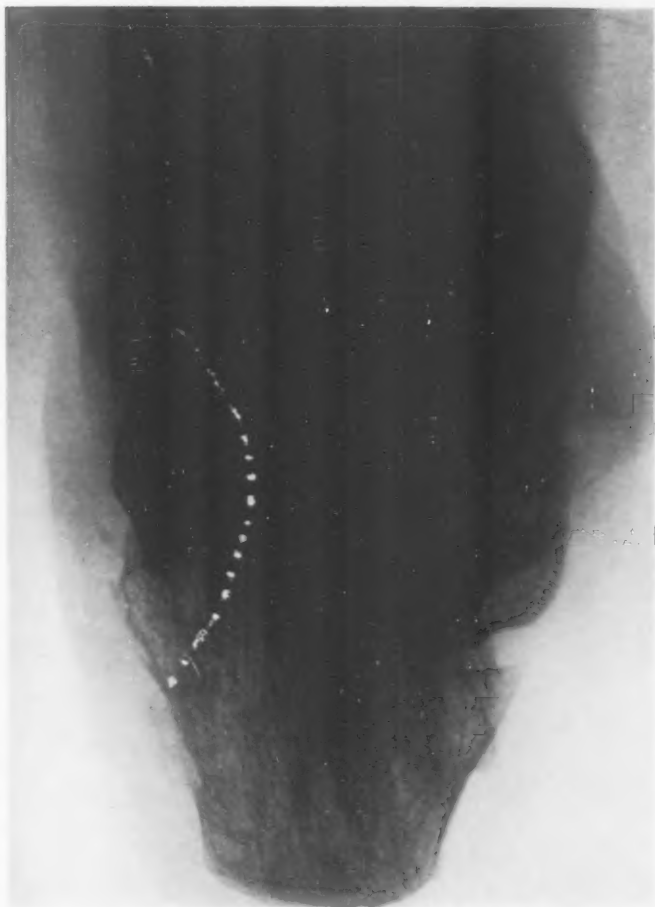


FIG. 4.--Case I. (From above and behind). Huge broadening of heel, with the peroneal plate shoved up squarely against the external malleolus. White dotted line shows roughly, the amount of bone removed at operation.

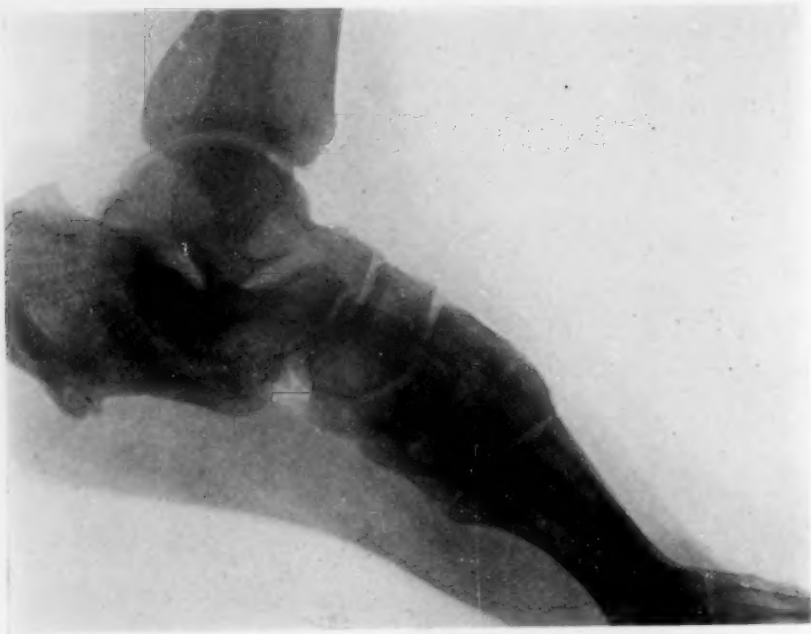


FIG. 5.—Case VII. Flattened heel. Thickening obvious at X. Spur on plantar surface from projecting fragment.

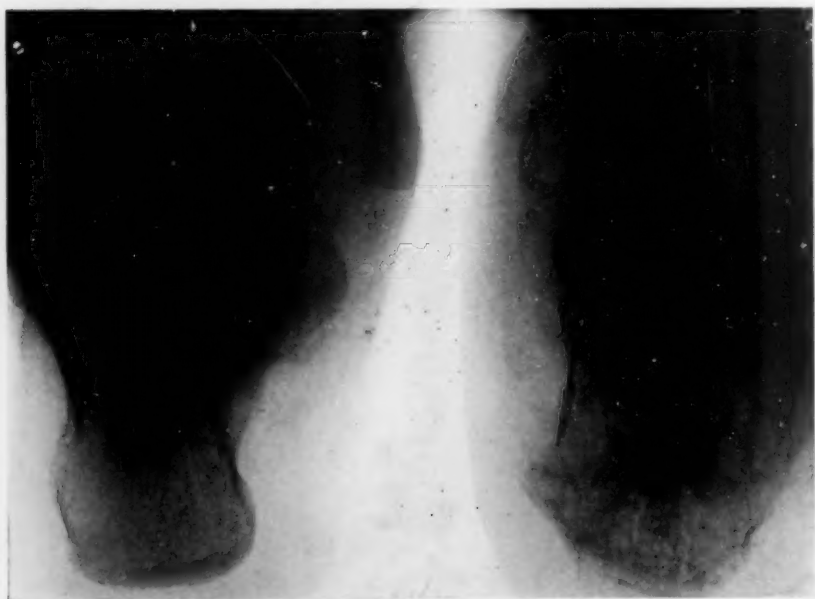


FIG. 6.—Case II. Fifty-two days after a "Gleich" operation. Heel now properly under the foot. Still much thickening, despite considerable removal of bone. Here, as always, tarsal bone repairs in excess.



FIG. 7.--Case IV. Right heel shortened; not much outward thickening. Main disability here was loss of lateral motion—restored by operation.



FIG. 8.--Case V. Left os calcis broadened; outer plate displaced far outward.





FIG. 9.—Case VII. Much broadening, excessive thickening below external malleolus. Marked osteoporosis.



FIG. 10.—Case IX. Moderate deformity only. The "spur" on the inner tuberosity is real, and corresponds with the tender point in the sole, but is a new growth and not the usual spur from projection of a fragment, as seen for instance in FIG. 3.

## OLD OS CALCIS FRACTURES

but the serous leakage (almost always present for a week or ten days in these cases) persisted a bit longer in this instance, perhaps because an unusual amount of excess bone was removed.

Returned to Doctor Gardner's care. Recovery very satisfactory, and final function, March, 1921, practically normal as to shape and motion. No complaint save of occasional pain on outer side of foot running forward to the last two toes.<sup>19</sup> Seen June 13, 1921; still has some discomfort, particularly in rising on toes, and is the first case I have seen with limited dorsal flexion. Supination about half; other motions normal.

CASE VII.—D. P. Seen by F. J. C., August 13, 1920. Man of fifty-six, not of vigorous type. Injury four months previous; fell fifteen feet. Referred by Dr. S. P. Strickland, of Waltham, Mass., for the Federal Mutual Liability Insurance Company.

Showed fracture of left os calcis with lateral motion entirely gone, crippling pain to the outer side on walking, enormous thickening to the outer side, confirmed by taking X-rays from behind and above. (See Fig. 7.) The X-ray showed less osteoporosis than the case-history; suggested, but did show a discomforting degree of arteriosclerosis of the vessels about the ankle. Operation advised, nevertheless.

Operation, August 24, 1920. Result: September 17th, entire removal of the conspicuous deformity, no swelling, slight tenderness, already about one-third normal motion. Later there were arthritic symptoms and static troubles with the anterior arch, etc. He started in at work the first of the year 1921, overworked a bit, and, despite shoeing and a plate, still has a foot that tires and swells a little and does not allow him full working time, but he has his motion, and no part of the symptoms (except a bit of nerve pain as in Case III) are at all referable to the region of the os calcis. They are anterior arch pains, and swelling of the whole leg on standing, due to a circulation not young and none too good.

CASE VIII.—H. K., May 26, 1919, fell forty to fifty feet, and broke his back (compression fracture first lumbar, without cord-lesions, and practically without nerve-root symptoms). Also he broke his right foot, but the diagnosis of Pott's fracture was made.

Accordingly he was sent in by the U. S. Mutual Liability Insurance Company. Examined by F. J. C., on July 27, 1920; the treated back was nearly well. The untreated foot showed a typical os calcis fracture with the usual total loss of lateral motion with lameness on the outer side, with massive bone-thickening beneath the external malleolus, and with tenderness in the sole as well, due to spur points projecting downward.

Operation July 30, 1920. Usual technic with removal of much bone at the side and of a spur also, projecting down into the sole toward the inner side. He did very well indeed for a time, during his month in hospital; after this less well, owing in part to his being a Russian, speaking an unattainable language, unable to understand very clearly about exercise and use.

This case lost his lateral motion to a considerable extent, and when last seen in November, 1920, while he was much better than before operation, with less pain and more motion, he was not fit for heavy labor. Not all this unfitness was due to the ankle, the back also had to be reckoned with, but the result of the os calcis operation in this case was less happy than in the others.

The operation worked well enough, the after-treatment didn't quite work out.

CASE IX.—P. S. Examination April 28, 1921, for the Federal Mutual Liability Insurance Company. A year ago, June 11, 1920, he fell and fractured os calcis right and left. Has been under treatment, plates, etc. Has almost no limp, and on detailed inspection little save moderate thickening on the left. On

the right there is more thickening and there is pain when he tries to come up on his toes, apparently from contact of the thickened bone with the external malleolus. The bone thickening toward the back is unusually heavy. Also there is a tender point below the internal tuberosity of the calcis.

There is little tendency to pronation on either side and motion both right and left is good—perhaps one-third normal (Fig. 9).

This case looks well enough, but, apparently owing to the bony thickening on the left side, he has been in the discard, industrially for over a year. The X-ray shows only moderate deformity.

He is to be operated on in the near future.

CASE X.—H. C., aged thirty-four. Painter. Broke heel two years ago in fall from staging. Has gone on under more or less treatment without essential change. He has the usual thickening, lateral motion not over a quarter in supination, and while he has no pain, if he loafs he is good for about two miles only, then has pain and stiffness. Is also stiff of mornings. Pain all referred to region below external malleolus where the thickening is heavy. He has backed and filled for two months but, having decided he is useless as things lie, he is to come up for operation June 15th.<sup>13</sup>

CASE XI.—It is only fair to give the other cases—non-operative.

M. B., aged twenty-nine. Navy yard electrician, referred by Maj. E. K. Sprague of the Marine Hospital of the Public Health Service of the Treasury Department; had had a double calcis fracture. He fell January 8, 1920, a distance of eighteen feet. Treated without reduction for seven and a half weeks. Then had some sort of correction under ether and a fortnight more of "cast" treatment. Has walked since then.

Examined, F. J. C., June 11, 1920. Showed clearly enough fracture of os calcis right and left. On the right it was not so bad—motion fair, pain little, bony thickening reasonable. On the left less motion and massive thickening to the outer side but little pain. This case looked hopeful.

Given lift inside heel, right one-quarter inch, left one-sixth inch, and shown how to do rotation exercises. (The patient is far above the average intelligence of the Navy's civil employees and likely to help.) September 16, 1920, he was "almost normal" as to motion and function.

Last seen October 20, 1920; he had practically recovered, without operation.

CASE XII.—J. P., aged thirty-four. Shoe-hand. March, 1921, fell twelve feet, landing on heels. Examined by F. J. C., May 9, 1921. (Referred by the Federal Mutual Liability Insurance Company.) A small man; not robust; walks with slight limp. The limp, analyzed, is a failure of the clean "take-off" on the right foot. No flattening of "arch." A good deal of thickening below the external malleolus with limitation of pronation and supination reduced to about one-third normal.

Physiotherapy treatment recommended and now being carried out.

He is gaining satisfactorily and will probably be restored to an approximate normal grade *without operation*. Motion June 21, 1921, almost normal.

CASE XIII.—D. V. A case of *avulsion* fracture—operated with entire recovery—does not really belong in this series.

CASE XIV.—Lahey. Fresh fracture, reduced byallet remodelling. Now, after six months, back on his job as apartment-house janitor not quite as good as new but serviceable.

CASE XV.—H., machinist. Fresh fracture of os calcis from fall. Sent to my service at Public Health Hospital No. 36, and reduced by the usual remodeling with the hammer and freeing of the joint motion with the hand. Seen June 7, 1921, three months later. Is back on the job, practically normal in stance and in motion.

## OLD OS CALCIS FRACTURES

CASE XVI is one on my service at the City Hospital on which I have no record data at the moment. This was a boy of twelve with a cracked os calcis on one side, a fractured os calcis with displacement on the other, a fracture not only with displacement, but with flattening and thickening as usual. Grace to his years, he has done well, and now, about eight months later, the case has become one of flaccid flat-foot on both sides, now being handled by plates and exercises with notable good results, so long as he wears the "rocker" plates. There is *no* disability, with the pronation corrected.

Let us not forget that these heel-lesions carry a very large chance of flat-foot in convalescence even if there is no bony valgus deformity. Flat-foot symptoms in os calcis cases can be treated orthopædically with physiotherapy after care.

Cases with marked thickening to the outside, with pain on walking or standing, nearly always call for operative interference, soon or late; they can, however, be so handled as to do away with most of the deformity, with most of the loss of motion and with most of the symptoms.

That this is possible is not sufficiently understood.

It is true that no one of the many crippled from injuries of this sort should be let drift along for many months without a trial of more modern methods.

All of them, I think, can be improved by operation and most of them set in the way of an improvement that presently brings them back into the wage-earning class.

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<sup>4</sup> Dislocations and Joint Fractures. Cotton, W. B. Saunders Co. 1st ed. 1910, pp. 609-621.

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<sup>6</sup> Partly, at least, owing to a campaign of reform by the Accident Board. These are primarily painters' and roofers' accidents: the reform accomplished (through the bait of preferential insurance rates) has brought about inspection of ropes and pulleys, and a decrease in os calcis lesions.

<sup>7</sup> For instance, I have found it practicable to remove nearly all of a comminuted scaphoid bone then to set the foot in proper shape and to secure a total replacement of missing bone.

<sup>8</sup> I hold no brief against this tenotomy, and do occasionally do it. *Only*, I recognize the disadvantages, and do it only when I must!

<sup>9</sup> In the evaluation of these results, please allow me a bit of lee-way for personal judgment. I know that two of these men are not yet back at work, but jobs are scarce at present in Massachusetts, and our industrial compensation is pretty liberal.

<sup>10</sup> Anterior arch troubles seem curiously frequent in these cases. They yield to usual handling. There is also, at times, a pain in the outer toes that is probably due not to statics, but to interference with the nerve—also rather common, but fortunately temporary.

<sup>11</sup> This was one of those common but yet distressing cases in which a year's idleness means forty pounds gain in weight, otherwise the interval might have been shorter.

<sup>12</sup> This complaint is common, I find, in non-operative as well as operated cases, due, no doubt, to nerve pressure. In no case has it been of serious severity.

<sup>13</sup> Operated on June 21st. Postero-astragal-calcaneal joint practically destroyed; restoration of lateral motion not very successful at operation, but return of function, including this motion, very satisfactory up to last visit, August 10th.

## THE INFLUENCE OF PHYSICAL THERAPY IN REDUCING DISABILITY TIME IN FRACTURES OF THE LONG BONES\*

BY JONATHAN M. WAINWRIGHT, M.D.

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IN connection with the papers on fractures presented in the preceding pages, it has seemed justifiable to draw attention to the one definite point indicated in the title of this brief note. Experiences during and after the war have in a general way impressed us with the value of physical therapy. However, the enormous number of cases treated by these methods in army hospitals have no similar series for comparison. For this reason it has seemed profitable to prepare a table showing the disability times in a fairly definite series of injuries, before and after the introduction of an adequate Physical Therapy Department.

The appended table of "before" and "after" cases comprises about 125 in each group. Cases included are uncomplicated simple fractures only: that is, cases of fracture of the humerus with, for instance, musculospiral paralysis, are not included, as they introduce an entirely new element. The figures are desired to show the average disability time of the ordinary case in each group of fractures. Further, the table only includes mine or railroad employees over fourteen years of age.

A study of this table gives very convincing mathematical evidence of the great economic value of physical therapy. In fractures of the clavicle and radius or ulna, where the disability times should not be long under any system, it has, of course, been impossible to cut the time to a large degree. But even here the disability in each case has been reduced over 10 per cent. For the femur, tibia or fibula the reduction has naturally been larger, *i.e.*, over 25 per cent. The reduction for the lower leg has been practically one month, and for the femur, two months. Speaking in terms of cash only, this reduction has saved the corporation I represent about \$4000 a year. And this limited fracture group is a small part of the total injuries of a year.

The most important deduction to be made from this study is the great advantage, almost the necessity for the establishment of a physical therapy department in every large general hospital.

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\* Read before the American Surgical Association, June 14, 1921.



## PHYSICAL THERAPY IN FRACTURES

TABLE SHOWING REDUCTION OF DISABILITY TIMES IN FRACTURES OF THE LONG BONES AFTER  
ESTABLISHMENT OF PHYSICAL THERAPY GYMNASIUM AT MOSES TAYLOR  
HOSPITAL, SCRANTON, PA.

	BEFORE	AFTER	Saving	Percentage
	Days disabled	Days disabled	in days	improve- ment in dis- ability time.
Clavicle .....	67	59	8	12
Humerus .....	125	90	35	28
Radius, ulna, or both .....	76	64	12	16
Femur .....	239	180	59	25
Tibia, fibula, or both .....	121	92	29	24

Times are for uncomplicated simple fractures. Males over fourteen only. All mine or railroad employees.

## OPERATION FOR THE CURE OF ANEURISM\*

BY ARCHIBALD MACLAREN, M.D.

OF ST. PAUL, MINN.

IN preparing for an operation on a case of traumatic popliteal aneurism recently, I reviewed the literature on this rare condition, and found that the procedures advocated by Watson Cheyne, in 1900, and also by Bull, in 1904, had all been abandoned for the new operation advised by Doctor Matas. The cause of this change was due to the fact that in the older procedures so many cases of gangrene occurred or the cases which escaped gangrene were followed by a relapse of the aneurism.

Several modern text-books give the impression that reconstructive aneurismorrhaphy (Matas) was the operation usually employed. Illustrations showing the sacciform aneurism, depicting the false aneurismal sac, and also the picture of the fusiform sac, with the gutter in the bottom to mark the original vesicle wall, were both featured in every text-book.

In Matas' second presentation of this subject before the American Surgical Association in 1905, he complains "that great confusion and misapprehension still exists in the minds of many surgeons who had obtained their information from abstracts and second-hand descriptions given in the journals and text-books." In his report Matas listed twenty-four cases, five of his own and nineteen by other operators. Of the total number, eighteen were oblitative cases and four sacciform aneurisms where the lumen of the parent artery was restored by the closure of the single orifice of communication: Three cases of fusiform aneurism were operated upon for restoration of the artery wall by arterioplasty—only one remained cured when last heard from at the end of eighteen months; of the other two, one relapsed, and one was operated upon again for obliteration of the sac, two weeks after the arterioplasty.

Fortunately, for me and my patient, I came across a very sane and practical article on this subject by Dr. John Gibbon, of Philadelphia. Gibbon's conclusion, after a large experience with these operations, was, that arterioplasty or reconstruction of the vesicle wall was seldom safe or necessary—that in practically all cases the oblitative aneurismorrhaphy of Matas was the operation of choice.

CASE HISTORY.—E. H., age twenty-two years. Referred to me by Doctor Hopkins, of Arlington, South Dakota. When six years of age, he had a large abscess in his left kidney region which was opened and drained. At the end of four weeks the drainage ceased and the opening was closed, and he had no further trouble with his kidney. When the boy was fourteen years old, which would be about eight years ago, he was accidentally shot with a .22-calibre rifle. The muzzle of the

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\* Read by title before the American Surgical Association, June 14, 1921.



FIG. 1.—Showing swollen condition of affected leg.

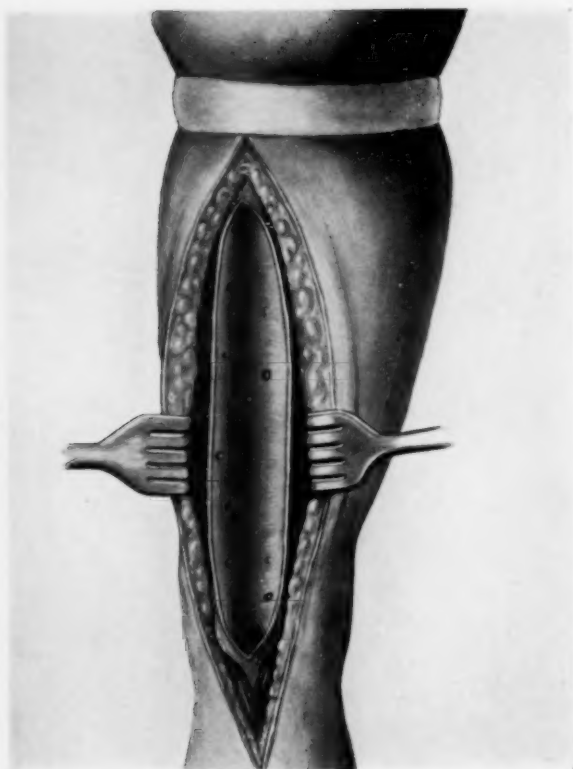


FIG. 2.--Fusiform traumatic aneurism of the femoral artery.

## THE CURE OF ANEURISM

rifle was about four feet away from the point of entrance. The ball struck him from behind in the upper part of the right popliteal space, probably injuring the arterial wall and imbedding itself in the internal condyle of the right femur. There was not much bleeding. His physician put him to bed for one week. He has not had any trouble with his leg until quite recently. He has noticed that the right leg was larger than the left, and that it tired more quickly. It might be interesting to note, that this boy entered the United States Army and served through the entire war, including service in France.

In the fall of 1920, he commenced to have a sharp pain in the right groin, especially when tired. He consulted Doctor Hopkins, who made an examination for hernia. No hernia was found, but there was a marked dilatation of all the superficial veins, especially in the foot and calf of the leg. There was a very marked thrill all through the leg, over every artery and vein. This thrill extended up into the iliac vessels. The upper leg was one and one-half or two inches longer than the left. The most marked swelling and the maximum thrill were over the popliteal space.

Examination of abdomen and chest showed nothing pathological; urine and Wassermann were negative. The X-ray röntgenogram showed the bullet imbedded in the internal condyle of the right femur, but no necrosis or other diseased condition about the bullet.

The diagnosis of a large fusiform traumatic aneurism was made and operation was advised.

The operation was performed at the Miller Hospital, St. Paul, December 16, 1920. An Esmarch was applied about the upper thigh, just below the fold of the buttock. An incision over the dilated artery demonstrated a fusiform swelling of the femoral artery, extending up to the Esmarch and down to the lower end of the popliteal space. Upon opening the sac and cleaning out the clots we found many large vessel openings inside of the sac—about twenty in number. It was not possible to determine which one of these openings communicated with the vein; no gutter or other evidence of the original arterial wall was present; there was no false sac. The entire thickness of the arterial wall constituted the aneurismal sac. Each one of the openings into the sac was separately sutured with fine chromic catgut.

The constrictor was loosened. One or two bleeding-points were reinforced with chromic catgut. Then the entire sac was obliterated by several continuous chromic catgut sutures. The collateral circulation was so good in this diseased leg that when the operation was finished the color and superficial heat were just as good, if anything even better, than in the normal leg. The thrill entirely disappeared and has never returned. He made a rapid recovery, was able to walk in three weeks, and is now well except for a slight keloid condition of the scar. Doctor Hopkins reported on March 16, 1921: "The leg is swollen below the knee, but above that point is normal. On June 2nd, Doctor Hopkins writes: "Regarding the present condition of our patient, I would say, that he is in good shape; the wound is entirely healed, and there is no evidence of a relapse of the aneurism.



## LIGATION (PARTIAL OCCLUSION) OF THE ABDOMINAL AORTA FOR ANEURISM\*

REPORT OF A RECENT CASE WITH A RÉSUMÉ OF PREVIOUS CASES

BY GEORGE TULLY VAUGHAN, M.D.

OF WASHINGTON, D. C.

JUST one hundred and four years ago, Astley Cooper did the first operation of ligation of the aorta and the operation has been performed about nineteen times since, but in no case can it be said to have been successful in man according to the cases reported up to the present time. Death has always followed in from a few hours to a few months from shock, hemorrhage, infection or something directly connected with the operation, except Hamann's case which died from hemorrhage from a bed sore.

Experiments on the lower animals, dogs, sheep, and goats, by Luigi Porta in 1838-40, both by partial and complete occlusion of the aorta by ligature, proved that such operations were by no means necessarily fatal, and he published some beautiful drawings of the collateral circulation established in animals whose aortas had been ligated more than a year before.

In more recent years the work of Halsted along the line of partial and gradual occlusion of large arteries by means of metallic bands has been of great value in demonstrating a method of occlusion without causing ulceration of the walls of the vessel.

In five of the twenty cases mentioned in this article, including my own, there was no ulceration, and in none of the five was there complete occlusion of the lumen of the aorta, and these were the only patients, excepting Keen's, who lived long enough to give any expectation of complete recovery from the operation. Tillaux's patient lived thirty-nine days, Halsted's two patients forty-one and forty-seven days respectively, Hamann's six months and two days, and my patient is still living and working, one year and four months after operation.

H. B., male, white; age thirty-nine, bricklayer, was referred to me by Dr. James A. Gannon.

*History.*—Had typhoid fever at ten years of age, "blood poisoning" at nineteen, and soon after that a chancre. For three years he has been suffering with pain in the abdomen and back. Two years ago his appendix was removed, and as he continued to have pain and developed a swelling in the abdomen just above the navel he was again operated on, November 5, 1919, when the aneurism was discovered and the operation was carried no further. As the patient gave a positive reaction to the Wassermann test, he was treated for a while for syphilis. This had no appreciable effect on the aneurism; therefore I decided

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\* Read before the American Surgical Association, June 16, 1921.

## LIGATION OF ABDOMINAL AORTA

to try ligation of the aorta according to Halsted's principle of incomplete occlusion of the lumen of the vessel, using a piece of tape instead of the metal bands. January 23, 1920, the abdomen was opened, the aneurism, about one inch and a half in diameter, seemed of the saccular type and sprang from the left side of the aorta behind the pancreas about opposite the origin of the superior mesenteric artery. It was decided to place the ligature below the aneurism according to the Brasdor method. The peritoneum was opened, the aorta exposed and a piece of cotton tape one-half inch wide was carried around the vessel about two inches above its bifurcation and just below the origin of the inferior mesenteric artery. Two turns of one end of the tape made the surgeon's or friction knot, which was drawn gradually tighter and tighter until pulsation was no longer perceptible in the iliacs and barely so in the aorta below the ligature, then the knot was completed, the ends of the tape cut off and the abdomen closed.

Nothing unusual was noticed afterwards, such as increased blood pressure and pains in the lower extremities when the patient recovered from the anæsthetic.

Next day his condition was satisfactory—no pain or paralysis of legs, and the color and temperature were good. Pulse distinctly felt in left foot but none in the right—both equally warm and comfortable. A slight blowing sound could be heard by the stethoscope over the left external iliac, but none over the right. Pulsation was faintly perceptible in the left iliac but absent in the right.

Recovery from the operation was normal but patient was kept in bed most of the time for two months and potassium iodide was given. When he left the hospital March 30th the pain in back and abdomen was much less, the murmur of the aneurism was not as loud but was softer and more musical in character.

Some time during the month of May, against advice, patient returned to his work as bricklayer.

June 18, 1920, he was examined. Says he feels better than he has for years—no pain of consequence and he eats, sleeps and works well. The aneurism seems about one-half its original size. A soft whining sound is heard directly over the aneurism and a rough sound over the aorta just below—both systolic. No sound over external iliacs. A feeble pulse is felt in the left iliac and none in the right.

August 29, 1920. Examined patient. Thinks he is entirely well, no pain, has gained twenty pounds in weight, and does eight to ten hours work bricklaying daily. The tumor cannot be made out by its pulsation. The circulation in the lower extremities is the same as before described.

February 13, 1921, when the last examination was made, one year and twenty-one days after the operation, everything seemed satisfactory except the patient's habit of going on occasional alcoholic sprees. He was hard at work and looking well. No aneurismal pulsation could be felt but a soft whining note ending in a rough note below could still be heard in the region of the aneurism and the aorta just below. A faint pulsation could be felt in the left iliac and dorsalis pedis, none

in the right iliac or vessels below, yet the two feet were normal in color, temperature and sensation.

When last heard from in May, 1921, one year and four months after operation, patient was in good condition, but just recovering from a spree.

Below is given a résumé of nineteen previous cases of ligation of the aorta and five cases of suturing or plugging of aneurisms of that vessel.

#### LIGATION

1. June 25, 1817, Astley Cooper ligated the abdominal aorta for a left iliofemoral aneurism in a man thirty-eight years of age. Death in three days.

2. July 5, 1829, James ligated the abdominal aorta for aneurism of the left external iliac artery in a man forty-four years old. Death from shock three and one-half hours later.

3. January 26, 1834, Murray ligated the abdominal aorta for right iliofemoral aneurism in a man thirty-three years old. Death in twenty-three hours.

4. August 5, 1842, Monteiro ligated the abdominal aorta for right iliofemoral aneurism in a man thirty years old. Death from hemorrhage ten days later.

5. June 21, 1856, South ligated the abdominal aorta for aneurism of the right common and external iliac arteries in a man twenty-eight years old. Death forty-three hours later.

6. March 8, 1868, Wm. Stokes ligated the abdominal aorta just above the bifurcation for right iliofemoral aneurism in a man fifty years old—silver wire ligature. Death from shock twelve and three-quarters hours later.

7. March 30, 1868, Hunter McGuire ligated the abdominal aorta for aneurism of the left external, and both common iliacs and the aorta, in a man thirty years old—the left ureter was included in the ligature. Death in a few hours.

8. August 6, 1869, P. H. Watson ligated the abdominal aorta for iliac aneurism in a patient, sex and age not given. Death from gangrene sixty-five hours later.

9. August 19, 1870, Czerny ligated the abdominal aorta (thinking it was the iliac) for gunshot wound of the thigh in a soldier twenty-seven years old. Death in twenty-six hours.

10. January 19, 1879, Czerny ligated the abdominal aorta between the two renals for tumor of the left kidney in a man fifty years old. Death in ten hours.

11. July 3, 1890, H. Milton ligated the abdominal aorta just below the renals for a ruptured aortic aneurism in a man forty-five years old. Death from anemia and shock twenty-four hours later.

12. December 12, 1899, W. W. Keen ligated the abdominal aorta just below the diaphragm, for ruptured aortic aneurism in a man fifty-two years old. Patient lived forty-eight days. There was *no suppression of urine* and the bruit in the aneurism did not disappear. Death from hemorrhage from the ligature cutting through.

13. January 20, 1900, Tillaux ligated the abdominal aorta just

## LIGATION OF ABDOMINAL AORTA

above the bifurcation for ruptured left iliac aneurism in a man fifty-six years old. Death thirty-nine hours later. He grew gradually thinner until death. There was no ulceration at the point of ligation and the lumen of the aorta was not completely obliterated, permitting the passage of a grooved dissector.

14. May 1, 1901, R. T. Morris occluded the abdominal aorta just above the bifurcation with a soft rubber catheter and clamp forceps for aneurism proximal to the ligature in a woman twenty-four years old. Death fifty-three hours later from infection caused by gangrene of bowel in contact with the forceps.

15. June 20, 1904, A. Guinard ligated the thoracic aorta about the level of the ninth dorsal vertebra for aneurism of the end of the arch. Death three days later from suppression of urine. Guinard remarks that ligation above the renal arteries is incompatible with life, evidently not knowing the history of Keen's case.

16. January 1, 1905, W. D. Scott ligated the abdominal aorta just above the bifurcation for gunshot wound of the aorta and intestines, using a soft rubber catheter and forceps, in a negro woman twenty years old. Death one hour later.

17. December 18, 1905, W. S. Halsted applied his aluminum band to the thoracic aorta about 7 cm. above the diaphragm, partially occluding the lumen, for aneurism of the upper abdominal aorta. Pain was much relieved. January 10, 1906, twenty-three days later, a second band was applied to the abdominal aorta just below the inferior mesenteric artery distal to the aneurism, just occluding the femoral pulse. Death eighteen days after the second operation from rupture of the aneurism. No ulceration at sites of bands.

18. February 23, 1909, Halsted applied his band to the aorta between the renal and superior mesenteric branches for aneurism extending from the renal arteries to the bifurcation of the aorta in a physician fifty-three years old, producing partial occlusion. Great relief from pain. March 5th there were enlargement of the aneurism and signs of infection, and Finney wired the aneurism March 12th. Death April 11, 1909, from infection from a psoas abscess.

19. September 11, 1917, Hamann ligated the abdominal aorta just above the bifurcation for a pulsating tumor in the pelvis for which the right internal iliac had been ineffectually ligated, in a man fifty-one years old. Death March 13, 1918, six months and two days later, from hemorrhage from a bed sore. At necropsy no aneurism was found and the aorta at the site of the ligature was found only partly occluded having a lumen less than  $\frac{3}{16}$  inch in diameter.

## SUTURING AND PLUGGING OF THE SAC

1. April, 1906, R. Lozano reports an operation on the abdominal aorta by Matas' endo-aneurismorrhaphy for aneurism. Death eight hours later from shock and hemorrhage—the diseased artery walls would not hold sutures well.

2. In the summer of 1906, John C. Munro ligated the right phrenic artery and the coeliac axis and sutured with catgut the stump of the

sac of an aneurism of the aorta above and behind the celiac axis, in a man thirty-nine years old. Death that night from hemorrhage.

3. July 30, 1904, Tuffier exposed by dissection an aneurism of the arch of the aorta threatening to rupture through the skin. No pedicle to the sac was found and adhesions were extensive, so extirpation was abandoned and the thorax closed. Death five days later, suddenly—the operation not having hastened his death.

4. October 29, 1909, Tuffier operated on a man forty-nine years old, the aneurism showing as a pulsating tumor in the right upper sternocostal region over which the skin was thin and adherent. In exposing the aneurism by turning back flaps, it was ruptured, and, to stop the bleeding, the tip of the gloved left index finger was thrust into the opening. A tampon was then made by stuffing the finger of a glove, the finger was withdrawn and the stuffed glove finger substituted and sewed into place and the wound closed with drainage. The patient was up on the eleventh day and walking on the thirteenth. Next day, the fourteenth, the tampon was replaced by a new one of the same kind. Two days later death occurred suddenly, but not from hemorrhage or asphyxia.

5. Kummel reports, in the *Deutsch. med. Wochenschrift*, April 2, 1914, the case of a man forty-five years old, with an aneurism of the thoracic aorta just above the diaphragm. The aneurism was exposed by resecting three ribs close to the spine and just above the diaphragm, the aorta was controlled above and below with fingers, the aneurism slit open, the clots turned out, and the walls of the sac united with two rows of continuous sutures down to the lumen of the artery. Death in a short time from shock.

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## A NOTE ON THE TREATMENT OF SECONDARY HEMORRHAGE FROM THE BRANCHES OF THE COMMON CAROTID ARTERY\*

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FROM THE SURGICAL DEPARTMENT OF THE WASHINGTON UNIVERSITY MEDICAL SCHOOL, ST. LOUIS, MISSOURI.

It was a teaching of Kocher that to tie the common carotid artery in a person past middle life was always dangerous and, in the arteriosclerotic, equivalent to a death warrant.

It would seem that some surgeons tie this vessel rather indiscriminately and for somewhat trivial reasons, claiming to see no ill results. Their luck is better than mine.

I have ligated the common carotid in but three subjects who were over forty years of age. One was for a carotid body tumor that completely surrounded the bifurcation and had materially reduced the calibre of the internal division. This patient survived without immediate symptoms of brain ischæmia, but the later history is not known. In the other two cases, although partial compression of the artery preceded the ligation for a period of more than twenty-four hours, both died with marked cerebral symptoms apparently referable to ischæmia. An autopsy could not be obtained in either case.

I have ligated the common vessel about six times in people under thirty years with only transient cerebral symptoms in one case, but I am so convinced of the dangers of this ligation in elderly people that I allowed one old man to bleed to death while making puttering attempts to control a secondary hemorrhage from one of the larger branches of the external carotid rather than tie the common artery, which I knew perfectly well to be the only sure method of controlling the bleeding.

It is an old teaching in English surgery, rather generally accepted, that when a true secondary hemorrhage occurs in the neck from one of the primary divisions of the common carotid or from one of the primary branches of the external carotid near the bifurcation, only ligation of the common artery will prevent fatal hemorrhage. Death may occur within a few minutes or the first bleeding may be slight and cease spontaneously or in response to some minor proceeding, but it will recur and continue to recur. The reasons for this are that the vessel walls are held patent by the induration of the tissue and that the width of the vessel is so great compared to its length that the clot has no opportunity to organize. The secondary hemorrhage here referred to is that due to infection, the ligature cutting through the vessel wall, or the clot being dissolved or blown out before permanent repair is established.

In my own practice I have not seen a true secondary hemorrhage in the

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neck, corresponding to the above definition, in over eight years, or since first heeding the advice of Billroth to neither suture any wound in the floor of the mouth nor to suture without free drainage any wound that contained a ligated carotid or a ligated primary branch.

I have had, however, two cases that somewhat approximated true secondary hemorrhage, the successful outcome of which suggested a plan that I hope might prove efficient in dealing with true secondary hemorrhage in this locality.

The first of the two cases just referred to was a hemorrhage following the throwing off of a slough after a complete removal of the tongue, with a cautery, right at its attachment to the hyoid bone. In this case the bleeding ceased spontaneously, showing that the fluids in a foul pharynx would not necessarily prevent the formation of a permanent clot in the open stump of the lingual artery.

It has been my custom for some time in dealing with carcinoma of the tongue or pharynx to ligate the lingual and facial vessels as far from their origin as possible, usually about an inch, and leave the ligated ends protruding into the pharynx with no protection whatsoever.

The second of the two cases referred to above is the only one of the cases treated by the method just described in which secondary bleeding occurred and this was not a true secondary hemorrhage as above defined. Three days after removal of the tongue and following a coughing spell, there was a persistent arterial bleeding, the blood coming from within the right side of the pharynx. On opening the right half of the submaxillary wound it was found that the stump of the facial artery stood up in the pharynx very much as it was at the time the submaxillary wound was closed at operation, and that just proximal to the ligation there was a fair-sized uncontrolled branch the continued circulation in which prevented the formation of a firm clot in the stump of the artery. Further, it was found that another very minute branch that arose close to the preceding had been partially torn from the indurated wall of the stump and there was a pulsating stream of blood the size of a pin. No attempt was made to ligate the bleeding point, but a ligature was placed on the uncontrolled branch referred to above and, after a few minutes' pressure on the stump, all bleeding ceased. The wound was left open for observation and next day the stump of the facial artery which had been nearly an inch long had shrunk entirely out of sight behind the digastric muscle, and it gave no further trouble.

My conclusions from personal observations are:

1. That secondary hemorrhage of the carotid artery and its branches is to be prevented by not suturing wounds that extend through the floor of the mouth and by packing or freely draining all wounds in the neck, above the level of the thyroid cartilage, that contain a ligated primary branch of the carotid artery.

2. That secondary hemorrhage from a ligated primary branch might possibly be controlled by previously having placed the ligature as far from the



FIG. 1.--Showing the appearance of the space left after the removal of the tongue and submaxillary structures, after the author's method of radical operation for carcinoma of the tongue. (Note) Attention is particularly invited to the facial arteries standing up in the pharyngo-buccal cavity. They receive no further attention. The wound is closed by turning down and suturing the submaxillary flap of skin and platysma myoides muscle which is here shown turned up over the chin.

(Note) "Operation for Advanced Carcinoma of the Tongue or Floor of the Mouth." *Surgery, Gynecology and Obstetrics*. (Feb. 1920.)



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carotid as possible and when bleeding actually occurs, (*a*) to free the stump from the surrounding indurated tissues, (*b*) to ligate any branches that are given off proximal to this ligature and, if necessary, to loosely re-ligate the stump itself as far from its origin as possible.

If it is found necessary to place the ligature on the bleeding stump so close to the external carotid as to preclude the formation of a proximal clot, then the external carotid itself should be exposed and a ligature placed on each branch and on the trunk at least an inch from the bifurcation, in the hope of establishing a permanent clot in the external carotid itself. In this latter fashion I have successfully avoided ligating the external carotid dangerously close to its origin in a wound I knew would become infected.



## THE CAUSATION AND AVOIDANCE OF CEREBRAL DISTURBANCES IN LIGATION OF THE COMMON CAROTID ARTERY\*

BY LEONARD FREEMAN, M.D.

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THE danger to the brain in ligating the common carotid is generally recognized and has been emphasized in all our text-books. For instance: "The surgeon is always in doubt whether the patient will come out of the anæsthesia, and if he does whether he will exhibit hæmiplegia or progressive cerebral softening" (Binnie); and again, "From the beginning of carotid surgery to the present time the dread of cerebral disturbances has invested the technically simple operation of ligating the common carotid artery with a gravity and anxiety, that are associated with few other ligations" (Matas).

The percentage of cases in which the brain is affected has been placed as high as 54.5 (Le Fort), but 20 to 25 per cent. is generally recognized.

The almost universally accepted cause is anæmia with softening of the brain; from inadequate collateral circulation, due to defects in the circle of Willis. This plausible theory is supported by—(1) the occasional finding of such circulatory anomalies in fatal cases; (2) the possibility of producing cerebral softening" (Binnie); and again, "From the beginning of carotid common occurrence of these disasters after middle life, which can be explained by lessened dilatability of the collateral vessels from increased rigidity.

The acceptance of the anæmia theory naturally has led to various procedures to determine the presence or absence of an adequate collateral circulation before resorting to permanent closure of the carotid, such as—temporary ligation (Halstead, Jordan); gradual narrowing of the arterial lumen by encircling metal bands (Halstead, Matas), which is supposed to give time for the collaterals to expand; simultaneous ligation of the internal jugular (Ceci), with the idea of inhibiting cerebral anæmia; and lastly, the abandonment of ligation in favor of aneurismorrhaphy, or arterial suture in the case of wounds, so as to preserve the circulation (Rehn).

Scant attention has been given to the objections to this time-honored theory. It fails to explain:

1. The interval which nearly always occurs between the operation and the advent of cerebral symptoms, which varies from a few hours to several days, or even two or three weeks. If anæmia were the cause, symptoms should occur at once.

2. The *suddenness* of the onset of the symptoms. If produced by anæmia, they should come gradually.

3. The greater frequency of brain complications in ligation of the common over that of the internal carotid. Theoretically, it should be the reverse,

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\* Read before the American Surgical Association, June 14, 1921.

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owing to the possibility of a retrograde flow of blood from the external carotid. This, in fact, has actually been observed to occur in certain operations in the neck.

4. Autopsies in which no arterial sclerosis and no deficiencies in the circle of Willis have been found (Zimmermann).

5. Cases in which the artery was temporarily compressed for a long time before operating, without ill effect, with disaster resulting after ligation (Goldhammer).

6. Cases in which a preliminary, gradually increasing constriction of the lumen by metal bands was resorted to, and still cerebral softening followed permanent tying of the vessel (Gruber and Werner).

7. A case (Perthes) where the common carotid was temporarily tied during the extirpation of a cervical tumor; but as soon as the ligature was divided and the *circulation* reëstablished hæmiplegia followed, which cannot be explained by anæmia.

Another explanation for softening of the brain following ligation of the common carotid was advanced by Zimmermann, in 1892, and supported more recently by Stierlin, Perthes<sup>1</sup> and a few other observers. Although receiving scant recognition it has much in its favor and deserves serious consideration. It is based upon the fact that when the carotid is tied its inner coat is ruptured, which leads to the formation of a thrombus; and it is either the direct extension of this thrombus, or much more frequently the lodgment of detached emboli, which may block the cerebral arteries and causes anæmia and softening. Rarely, when the intima is smoothly divided, thrombosis does not result; but where the edges are ragged or curl into the lumen of the vessel coagulation is inevitable.

The points in favor of this theory are numerous and convincing. It explains, for instance, why—

1. There nearly always is an interval between the operation and the cerebral disturbances, during which a clot is formed and emboli detached.

2. The brain symptoms come suddenly, like an apoplectic stroke, due to the lodgment of emboli.

3. Autopsies done in fatal cases following ligation, and also experiments upon animals, repeatedly have demonstrated the presence of ascending thrombosis and of embolism.

4. Tentative compression or temporary ligation, even when unaccompanied by symptoms, does not insure that disaster will not result when the artery is permanently tied, and neither does the gradual diminution of the arterial calibre by metal bands or otherwise.

5. Disaster is more frequent in ligating the common than the internal carotid, because the return flow from the external carotid is particularly liable to detach emboli from an extending thrombus in the main arterial trunk.

6. The release of a temporary ligature, with *reëstablishment* of the circulation, may initiate cerebral trouble, as demonstrated by Perthes.

The preponderance of softening of the brain in the aged is not difficult

to understand because of the tendency to increased brittleness of the internal coat due to arteriosclerosis. This leads to increased likelihood of rupture from ligation and to roughness of the torn edges, thus increasing the tendency to thrombosis.

That ligation does not always produce trouble is clear when one remembers that the furrow produced in the inner coat by the ligature is sometimes so smooth that coagulation fails to occur, and that emboli do not always become detached even if a thrombus is present.

The fact that cerebral symptoms once in a while occur during an operation, so that the patient comes out of the anæsthetic paralyzed, does not militate against the embolus theory. Such occurrences usually take place in connection with aneurisms, and admit of explanation on the ground that emboli have been dislodged by manipulation of the aneurismal sac. This has led Perthes to emphasize the necessity of closing the distal artery before the sac is touched.

Unquestionably it cannot be denied that anomalies in the circle of Willis occur; but it is significant that when they have been found after death following ligation of the carotid, it has not been proved that thrombosis or embolism was not present also. Nevertheless, in spite of theoretical considerations, we are not yet warranted in assuming that brain disturbances do not occur occasionally from anæmia alone. Such an instance recently has been reported by Moser,<sup>3</sup> in which the marked symptoms resulting from a temporary ligation of the common carotid immediately were relieved by removal of the ligature. In such a case, however, a question must always arise as to the permanency and seriousness of the cerebral condition.

If this embolic theory is true, the older method of ligation should be discarded in favor of one which does not cause rupture of the internal coat, thus avoiding the formation of a thrombus. One way of accomplishing this is by the use of a metal band (Halstead, Matas), and another by the employment of a strip of fascia lata. The latter is preferable because it is not a foreign body, is less likely to injure the artery, and is always at hand when wanted.

The technic described by Perthes is simple (see illustration). A strip of fascia lata, three or four inches long and half an inch wide, is obtained from the thigh, wrapped once or twice around the artery, tied in a half-knot, and the knot secured by a few sutures. It is pulled just tight enough to obliterate the vascular lumen without rupturing the internal coat. If desired, additional pressure and security against injury may be had by folding lengthwise another fascial strip several times upon itself and placing it between the knot and the artery. As is well known, fascia lata will not stretch or break easily, hence it makes an ideal material for the purpose.

It goes without saying that aneurismorrhaphy, as well as the suture of wounded vessels, cannot be discarded; but they should be employed only when they can be done easily and safely.

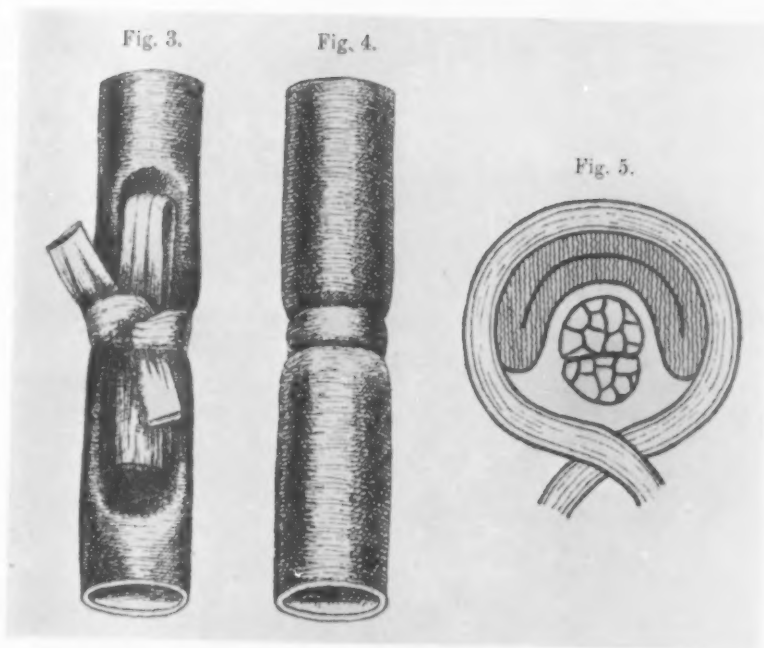


FIG. 1--Ligation of common carotid artery with a strip of fascia lata, according to Perthes  
(From Archiv. Klin. Chir.).





## LIGATION OF THE COMMON CAROTID ARTERY

The following case is reported in order to add to the statistical material which will assist in deciding which of the two theories is the correct one:

A woman, about fifty years of age, with a blood-pressure of two hundred, noticed, four or five months previously, a beginning swelling just above the right sterno-clavicular junction. This was accompanied by a disagreeable throbbing in the neck, and neuralgic pains over the right side of the head posteriorly, and the entire right shoulder. There was also difficulty in swallowing and a sense of choking. An X-ray picture demonstrated, however, that the dysphagia was due to a cardiospasm (pressure on the pneumogastric?) and not to direct interference with the oesophagus. These disturbances increased rapidly and finally became so annoying that she applied to her physician, Dr. Alice Guthrie, for relief. Examination revealed a pulsating, expansile tumor, about as large as a walnut, which was evidently an aneurism of the first portion of the carotid, or of the innominate.

An operation was done, on January 3, 1921, in which was found a marked fusiform dilatation of the innominate, the first part of the subclavian and the first part of the carotid. Although the condition did not seem bad enough to justify a ligation of the innominate or subclavian, it nevertheless demanded that something be done to relieve the symptoms and prevent an increase of the trouble. Hence the following procedure was decided upon: Two strips of fascia lata were obtained from the thigh, each about four inches long and one-half inch wide. One of these was wound twice around the dilated innominate and secured to itself by stitches. It was drawn tight enough to lessen the calibre of the vessel without obliterating it, the amount of tension being regulated by the distal pulsation of the artery. By this means it was hoped to reinforce the vessel and prevent its further enlargement, according to the suggestion of Halstead.

The other strip was given a double turn about the lower end of the carotid and tied in a half-knot, which was secured from slipping by sutures of chromic gut. This permanent ligature was carefully drawn just tight enough to stop the distal pulsation without danger of rupturing the internal coat.

Convalescence from the operation was without incident, there being no cerebral disturbance of any kind. The pulse in the right wrist remained normal, while that in the right common carotid was absent and remained so for at least two weeks.

The patient was relieved of all her annoying symptoms, including the throbbing, the cardiospasm and the various neuralgias. At the end of a month she was still in excellent condition and extremely grateful for the relief obtained. The pulsating and expansile tumor was no longer to be felt at the root of the neck, but a comparatively feeble pulse had returned in the carotid, due either to a collateral circulation from the back-flow through the external carotid or to reestablishment of the circulation through the point of ligation. If deemed necessary, the former occurrence could be prevented by simultaneous ligation of the external carotid, and the latter by applying an ordinary ligature to

the common carotid proximal to the fascial band and dividing the artery between them (Perthes).

*Summary.*—1. The great danger from cerebral disturbances in ligating the common carotid artery is universally recognized.

2. The accepted theory in accounting for this danger is that of anæmia, due to failure of collateral circulation arising from defects in the circle of Willis.

3. An apparently more rational theory, recently emphasized by Perthes, is that of thrombosis at the point of ligation, followed by embolism. This accounts for the suddenness of onset of the symptoms and the greater or less interval which precedes them. The preponderance of cases after middle life is explained by the greater brittleness of the inner coat of the artery producing ragged edges when divided by the ligature and thus inviting thrombosis.

4. If this latter theory can be substantiated by experience it will do away with much of the fear and hesitation of the surgeon when confronted by this comparatively simple operation.

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<sup>2</sup> In this connection it is of interest to note that in one instance a patient upon whom I had performed a hysterectomy for a uterine fibroid came out of the anæsthetic with a hæmiplegia from which she subsequently died.

<sup>3</sup> H. Moser, Zentralblatt f. Chir., No. 9, 1921, p. 321.

## SURGICAL ASPECT OF TUMOR OF THE BRAIN\*

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BOTH the morbidity and the mortality caused by all tumors of the brain, all tumors of the meninges and all tumors of the inner aspect of the skull result largely from increased intracranial tension, local, general, or both. The word tumor as here used is intended to apply also to infectious granulomata. These pressure phenomena are the result of an increase in the intracranial content—they are mechanical in origin. In 100 cases studied in the service of Doctors Halsted, Heuer and Dandy<sup>1</sup> they found that in 57 evidence of the increased intracranial pressure was manifested in the X-ray pictures by a separation of sutures. Mechanical defects are best remedied by mechanical measures. These statements, in the present state of knowledge, must, it seems to the writer, be accepted as true. They require qualification and exemplification, but in a general way they present a true picture. Logically, therefore, two facts seem to follow: (1) That all tumors occupying the cranial cavity should be taken into consideration in a discussion of brain tumors, as is done by Hertzler<sup>2</sup> and other writers. (2) That the subject of brain tumor is a surgical rather than a medical subject.

Last summer in Paris the writer was present at a clinic conducted by a surgeon of decidedly excellent repute. One of the cases was listed as "brain tumor." The operator proceeded to remove a large part of the frontal bone and, very much to his surprise, when the segment of bone came away, the tumor came with it. Technically, it was a tumor of the skull; practically, it was a tumor of the brain. This is not intended as an adverse criticism for the operation was well conceived and splendidly executed, but the incident is related in support of the contention that all tumors occupying the cranial cavity should be considered in discussing the general question as to whether tumors of the brain should be considered as primarily surgical rather than medical. It would seem obvious that if the majority of patients with brain tumor can be relieved or cured by surgery only, then these patients should be considered surgical subjects until the contrary is proven.

As late as 1902 Ransohoff,<sup>3</sup> in a paper read before the Surgical Section of the A.M.A., said: "Only 6 per cent. of all cases are suitable for operation." Bergmann, as quoted by Hoppe,<sup>4</sup> came to a like conclusion as the result of a study of 673 cases taken from various sources.

The writer takes it that these authors mean to convey the idea that only about 6 per cent. of tumors of the brain *per se* can be removed surgically. Certainly more than 6 per cent. of patients with tumors of the brain proper

\* Read before the American Surgical Association, June 15, 1921.

can be relieved surgically and a still larger per cent. can be relieved by surgery if tumors of the meninges and inner table of the skull are included. Ransohoff (*loc. cit.*) puts the three-year recoveries from operation in brain tubercle at over 25 per cent. As emphasized by Cushing<sup>5</sup> it is oftentimes impossible to differentiate between true tumor and what he calls pseudo-tumor cerebri. He further quotes and supports the statement of Tooth that even among the fatal cases are "many positive surgical successes, some almost brilliant considering the circumstances, and followed by relief of pain, improvement in sight and mental state and prolongation of life." Cushing operated upon 350 out of a series of 500. Headache is an almost constant symptom of tumor of the brain, and according to Paton, as quoted by Rawling,<sup>6</sup> either optic neuritis or atrophy occurred in 81.2 per cent. of 252 cases. Surgery, and surgery only, can relieve either or both of these symptoms in a large percentage of cases. Beriel<sup>7</sup> operated 8 out of 16 cases of glioma and advises calling the surgeon as soon as the diagnosis is made, but insists that no attempt be made to remove the tumor because simple decompression gives better results. The position taken by White,<sup>8</sup> Seguin,<sup>9</sup> V. Bergmann<sup>10</sup> and Koplik,<sup>11</sup> that gummata, non-localizable tumors, non-encapsulated tumor, tubercular tumor, and tumors of any sort in comatose patients are non-operable is no longer tenable. As long ago as 1892 Czerny<sup>12</sup> expressed the opinion that pathologico-anatomical results were not authoritative in brain tumor. Wyeth,<sup>13</sup> prior to 1894, operated two patients in coma due to brain tumor. Both patients became conscious and one was able to attend to business for seven months and to execute a will which stood. In neither case was the tumor removable. It is generally conceded now by surgeons of experience that decompression may be expected to alleviate the distressing symptoms of brain tumor regardless of its location or nature, but it is a humiliating fact proven by an extensive search of the literature that notwithstanding the advice of Cushing,<sup>14</sup> Sachs,<sup>15</sup> Sharpe<sup>16</sup> and others, a large number of patients are allowed to suffer an unconscionable time, amounting in the aggregate to decades, for the want of timely intelligent surgical interference. Early operation not only relieves the symptoms but tends to prevent the secondary changes which occur in the brain as a result of the tumor—the hyperplasia of Spiller.<sup>17</sup> To allow a patient to go blind or even to allow him to suffer over a long period in the hope of making a complete diagnosis, or in the hope of relief through antisyphilitic treatment, is almost a crime. The time which is considered reasonable during which antisyphilitic treatment may be tried is rapidly growing shorter. In 1893, C. H. Mayo<sup>18</sup> said, "tumors diagnosed as gumma should be treated medically for three months." Horsely,<sup>19</sup> in 1910, put the time limit for antiluetic treatment at six or eight weeks at the most, while Rogers,<sup>20</sup> in 1911, says, "from three to six weeks is long enough to test the utility of antisyphilitic remedies," and Sachs,<sup>21</sup> in 1920, puts the limit for palliative treatment at four weeks.

Especially in children is it necessary to guard against losing valuable time

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in the hope of giving relief by antisyphilitic medication. Rivista<sup>22</sup> found only one gumma in 140 cases of brain tumor in children, and in this case the child died after nine months of antisyphilitic treatment, which treatment did not seem to modify the gumma.

Frazier, in a letter to the writer, says, speaking of gummata: "In the first place, it is unimportant in the majority of instances to make a distinction, and in the second place, after you think you have made it, you probably find you have made a mistake, and an operation is often necessary to confirm diagnosis and to deal adequately with the lesion. To make a diagnosis of gumma does not exclude it from the possibility of a surgical lesion." It is well to recall here the observation of MacEwen made at the International Medical Congress in 1909 to the effect that avascular gummata would respond to antiluetic treatment only after pressure had been relieved.

It is well to recall here also the fact that decided remission in symptoms does not exclude brain tumor, nor does it indicate necessarily that the treatment used was the cause of the remission. Abercombie, in his work on "Diseases of the Brain," published in 1843, relates the case of a patient who became blind rather suddenly, whose sight was restored by an emetic, but lost again, and permanently, within an hour. Rudolf and MacKenzie, in the *American Journal Medical Sciences*, vol. cxxxviii, pp. 733-1909, report a very interesting case illustrating the extraordinary remissions that sometimes occur in patients with brain tumor.

Ballance (*loc. cit.*) states the case about right, in my opinion, when he says: "Decompression should be done before symptoms have become more than barely sufficient to enable a probable diagnosis of brain tumor to be made; one should never wait for pressure symptoms in the eye to develop." Cushing, in a recent letter to the writer, said: "I have seen patients with syphilomas become blind during treatment for them. I think a syphiloma is better treated like any other tumor."

Given a diagnosis of brain tumor the patient's interests are best served by an immediate operation; waiting for a complete diagnosis is dangerous. If for any reason delay in a given case is desirable, the time of the delay should not be arbitrarily limited on the authority of any one, but rather the case should be carefully watched, especially the eye grounds, and the operation done before irreparable damage has occurred. Then, too, the suffering which some of these patients endure may be, in and of itself, a sufficient warrant for a decompression operation. Personally, I am in favor of the suboccipital procedure in subtentorial tumors; however, as Cushing<sup>23</sup> suggests, it is questionable whether a decompression here is any more effectual than one placed elsewhere. For all other than subtentorial tumors Cushing's subtemporal operation is the one of choice, unless one desires to make some exploration in the hope of locating the tumor at the same time, in which case the operation may be planned along the lines advised by Hudson,<sup>24</sup> or the combined subtemporal decompression and exploratory operation described by Cushing.<sup>25</sup>



In 1902, and again in 1903, the writer <sup>26</sup> called attention to the use of the exploring needle as an aid in locating tumors, abscesses and cysts of the brain through the change in resistance transmitted to the surgeon's hand as the needle progresses. Since this time I have frequently referred to this diagnostic aid in discussing the subject, but for some reason it has never come into general use. The hollow needle is quite frequently used in cysts and abscesses, but one rarely sees a report of the use of the solid needle in the way suggested. In a recent letter Doctor Cushing says "that needling for brain tumor is employed by all so-called neuro-surgeons." The evidence contradicts this statement, in so far as concerns the use of the solid needle in the way and for the purpose here advocated. *Die Hirnpunction* of Neisser and Pollack and Krause <sup>27</sup> contemplates the use of a hollow, sharp needle, with its attendant dangers, for the express purpose of determining the presence or absence of fluid and for tapping the ventricles. The value of the needle in locating tumors and abscesses I have demonstrated, and Elsberg <sup>28</sup> also has discovered tumors in this way, which he says "would otherwise have been missed." However, the reports of cases make it plain that many exploratory operations for brain tumor result in failure because this simple, safe and valuable expedient is not generally known and used. In 1912 Willy Meyer <sup>29</sup> said in speaking of an exploratory operation for supposed cerebellar tumor, "The entire cerebellum was exposed and carefully explored with negative results. The patient died, and at the autopsy a large cyst was found in the left hemisphere, involving temporal and occipital lobe. Were it not that the sometimes dangerous consequences of aspirating the brain made surgeons fear the multiple use of the needle in intracranial operations, the cyst in this case might have been found and evacuated." I venture the assertion that this cyst might have been discovered by the use of the solid needle. Cushing, <sup>30</sup> in his article on a combined exploratory and decompressing operation, cites two instances of tumor "too far below the cortex to be identified." It makes little or no difference how far below the cortex the tumor is situated so far as concerns its detection by the use of the needle. The detection rests upon the difference in resistance offered to the progress of the needle by the normal as compared with the abnormal tissue. Spiller <sup>31</sup> says: "Deep probings where the tumor is not upon the surface are rarely of value and do harm." With the use of the solid needle the danger of "aspirating" the brain is eliminated, and from experience and study I am convinced that the procedure is relatively without danger and of great diagnostic value. The needle used should be long, slender, round, and rather dull. Elsberg has used a slightly roughened needle, and says by this means one is often able to recognize slight differences of resistance in the brain. I have not used a roughened needle in actual work but think the suggestion valuable, and shall act on it in the future. A fine trocar and canula, such as is used for intraspinal work, dulled slightly at the point and slightly roughened for about an inch at the distal end, makes an ideal instrument for exploring the

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brain. Coupled with the solid needle, one has also the canula in case he wants to tap a cyst or an abscess.

The writer has experimented with such a needle by imbedding in a fresh brain pieces of liver and then locating them by the sense of touch as imparted through the needle. He has also demonstrated the possibility of locating vessels and ducts in liver substance with the needle, and he ventures to suggest to neurologic surgeons who have not had experience with the solid needle for the purpose of locating tumors of the brain that if they will repeat these experiments they will be convinced of the value of the method.

With two- or three-stage operations I have no experience, and like Cushing, I do not look upon them with favor. However, it must be conceded that in some instances they become a necessity because of shock or hemorrhage or both, and in other instances advisable where one has failed to locate the tumor at the first operation in the hope that relief of pressure may make localization possible later on. The necessity for a two-stage operation for simple decompression must be very rare. It should be remembered, too, that some surgeons of large experience, like Von Eiselberg,<sup>32</sup> prefer the two-stage operation for the removal of tumors, on the ground that it is safer for the patient.

Drainage in this work should be looked upon as an evil which in some cases becomes a necessity. When employed it should be removed in forty-eight or seventy-two hours. Permanent drainage would prolong life and minimize the deformity in those cases in which it is impossible to remove the pathology. However, I know of no reliable and safe way of accomplishing this. G. A. Cathey<sup>33</sup> makes a tube of the dura and says that this "establishes permanent drainage," but I have not seen his original article and am unable to say upon what evidence his statement is based. We do know, however, that, generally speaking, fascial tube drains are disappointing. Halstead and Vaughan<sup>34</sup> say: "X-rays, radium and fulguration practically do not come into consideration in the treatment of intracranial tumors." Later reports are more encouraging, however. S. Nordentoft<sup>35</sup> has a record of twenty cases of brain tumor treated by Röntgen exposures with encouraging results. The favorable results in his "first series of eight cases have continued to date; there has been no recurrence of the growth or return of symptoms." Muskens<sup>36</sup> reports gratifying results from Röntgen-ray treatment in two cases of cerebellopontile tumor. Frazier<sup>37</sup> reports three cases treated with radium, in which the "growth of the tumor, in the light of the clinical evidence, has been arrested at least, the tumor possibly destroyed in periods of observation covering a maximum of eight years." In one of Frazier's cases the radium was buried in the tumor, in the pontile angle, in one (also cerebellar) the tumor was not exposed and four applications of radium were made following suboccipital craniotomy. In his third case the treatment consisted of combined use of X-ray and radium, together with pituitary and thyroid feeding following a sella decompression. Williamson, Brown and

Butler,<sup>38</sup> as a result of experiments with radium upon dogs for the purpose of determining the safe dosage of radium, say that "the experiments give assurance that in brain tumors which respond readily to radium, little or no damage will be inflicted upon the brain tissue surrounding the tumor if the radium is implanted in the growth. The dosage can be regulated so as to be destructive only to the periphery." Unfortunately, Frazier found no case of glioma which seemed to be favorably affected by radium. On the whole, however, the later reports as to the effect of radium and X-rays on brain tumors are very encouraging.

#### CONCLUSIONS

1. The term "brain tumor" should include all growths of whatever origin or nature, either in or on the brain.
2. Brain tumor is essentially a surgical malady.
3. Surgical intervention should follow promptly the diagnosis of brain tumor. Postponement of operation for the purpose of locating the tumor or in the hope of getting relief through aural treatment or for the purpose of determining its character is seldom warranted. Better a comfortable, contented patient without a complete diagnosis than a dead patient or a blind one with one.
4. Exploration of the brain with a solid needle is a valuable aid in the localization of tumors and is free from danger if properly done.
5. X-ray or radium therapy should be used in all inoperable cases in which surgical removal is impossible, and after removal of malignant tumors.

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## A SURGICAL APPROACH TO THE SPHENOPALATINE GANGLION\*

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THAT there are certain pain phenomena of the face that are not attributable to lesions of the trigeminal nerve, no one will question. That some of these pain syndromes are relieved by cocainization of the sphenopalatine ganglion I have demonstrated on many occasions. The sphenopalatine ganglion derives its sensory supply from the maxillary division of the trigeminal nerve but the conventional operations upon the trigeminal tract give absolutely no relief to these atypical neuralgias.

Since the sphenopalatine ganglion has intimate connection, through the large superficial petrosal nerve, with the sympathetic system, one wonders whether the pain of these neuralgias may be of sympathetic origin. There is nothing very speculative in this supposition, since in other territories there are painful conditions in the origin of which the sympathetic system is an acknowledged factor.

Attempts to relieve these neuralgias by alcoholic injection of the sphenopalatine ganglion, as proposed by Sluder, meet either with only partial success or with failure. Knowing the minute dimensions of the ganglion and the difficulty of access to it, one can readily understand why the results of injection are in many instances unsatisfactory and bear no analogy whatsoever to alcoholic injections of the divisions of the Gasserian ganglion. Having given much thought and time to the study of these neuralgias, presumably related to the sphenopalatine ganglion, I had rather reached the conclusion that unless a method for extirpation of the ganglion was at our command we had reached an impasse. Only by the extirpation of the ganglion in a series of appropriate cases will we be able to speak with any positivity, either as to the etiology or as to the treatment. If there is a clinical entity—call it Meckel's neuralgia if you will—the extirpation of Meckel's ganglion should be curative in effect, should it not?

Upon this assumption, therefore, my assistant, Dr. Francis C. Grant, and I have been at work in an attempt to find a way of approach to the ganglion which would make it accessible for purposes of extirpation. The approach we now present, I venture to hope, will prove a practical solution of this problem. In the two instances in which the operation was performed, there proved to be no inherent technical difficulties in gaining access to the fossa in which Meckel's ganglion is located. The anatomical landmarks (Figs. 1, 2, and 3) and the various steps in the procedure as portrayed in the illustrations (Figs. 4, 5, 6, 7, and 8) require little amplification in the text.

\* Read by title at the meeting of the American Surgical Association, June 16, 1921.

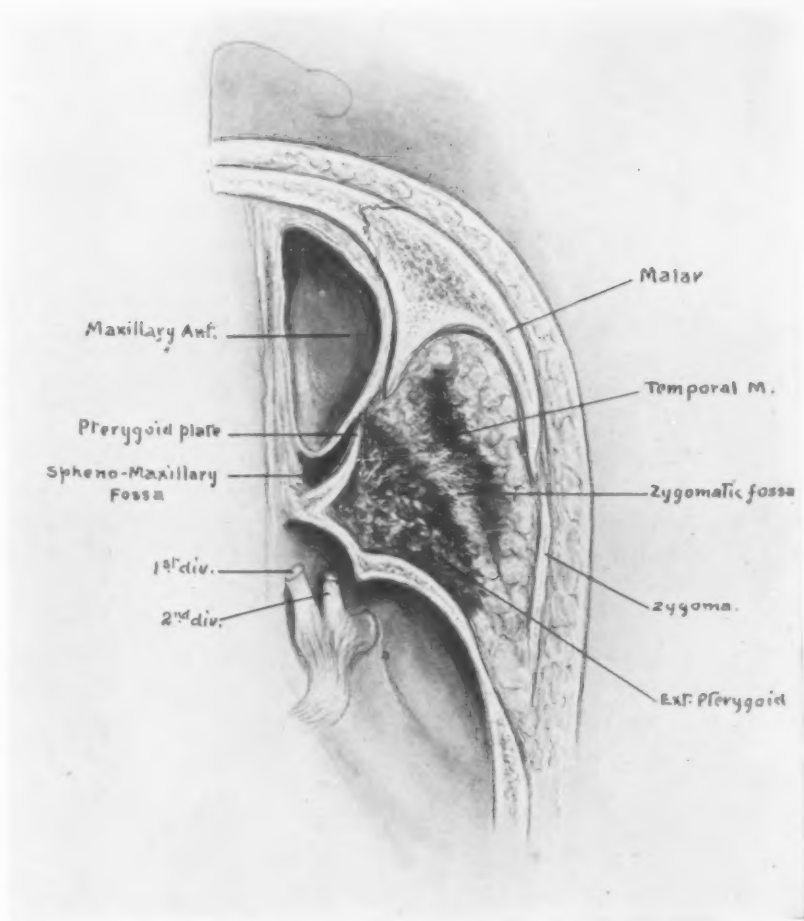


FIG. 1.--Horizontal section.

Anatomical relationship of the structures of the zygomatic and sphenomaxillary fossae.



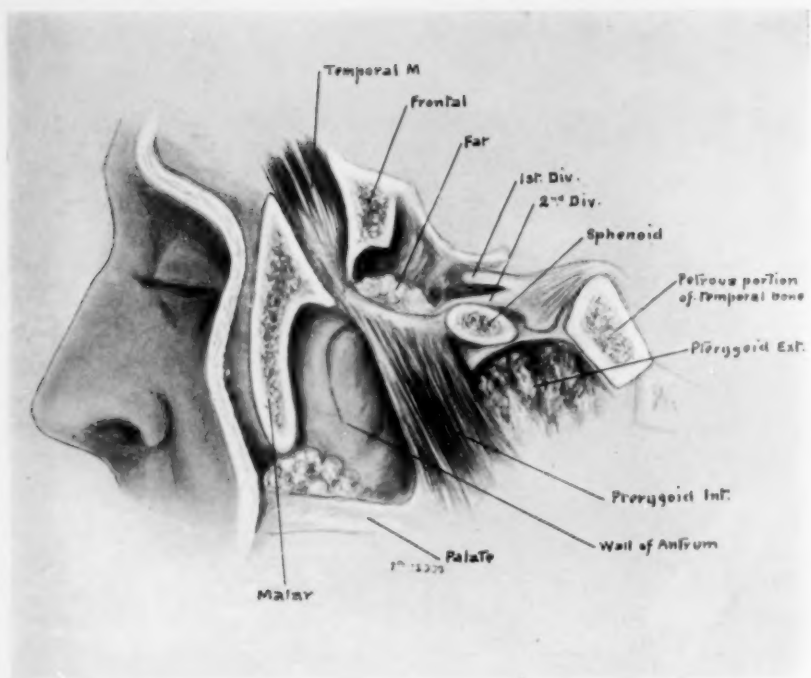


FIG. 2.—Vertical section. (a) Relationship of the structures in the zygomatic fossa.

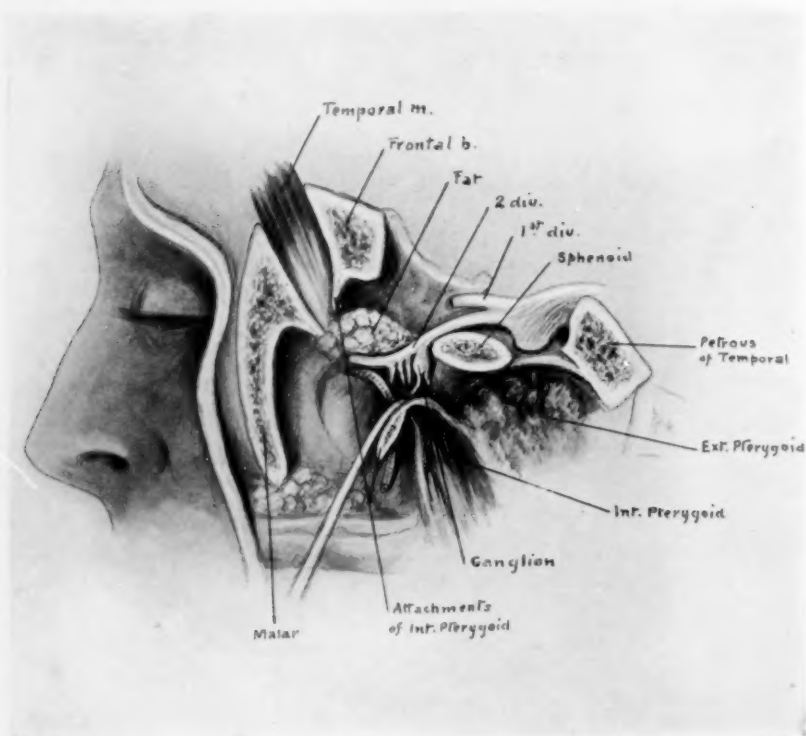


FIG. 3.—Anatomical relationship of the second division and to the sphenopalatine ganglion in the sphenomaxillary fossa.

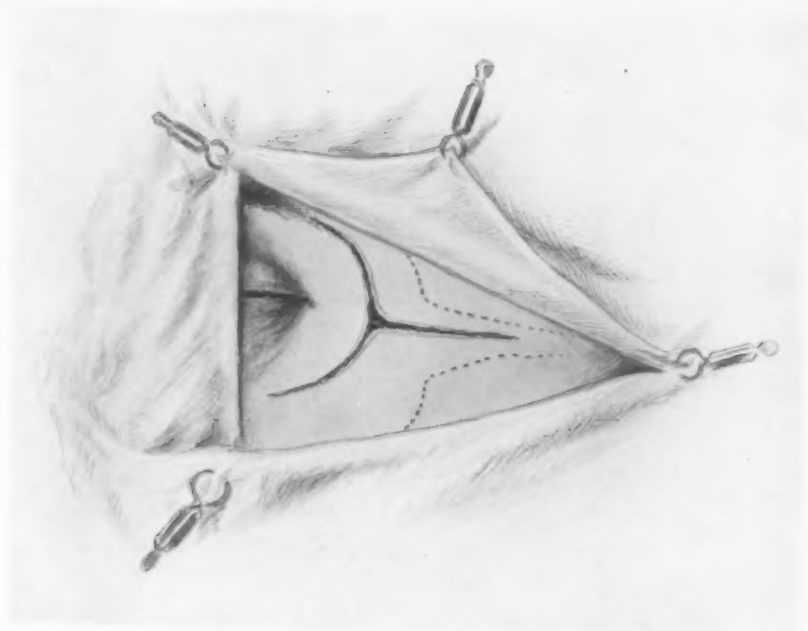


FIG. 4.—The incision in relation to the orbit and the zygoma.

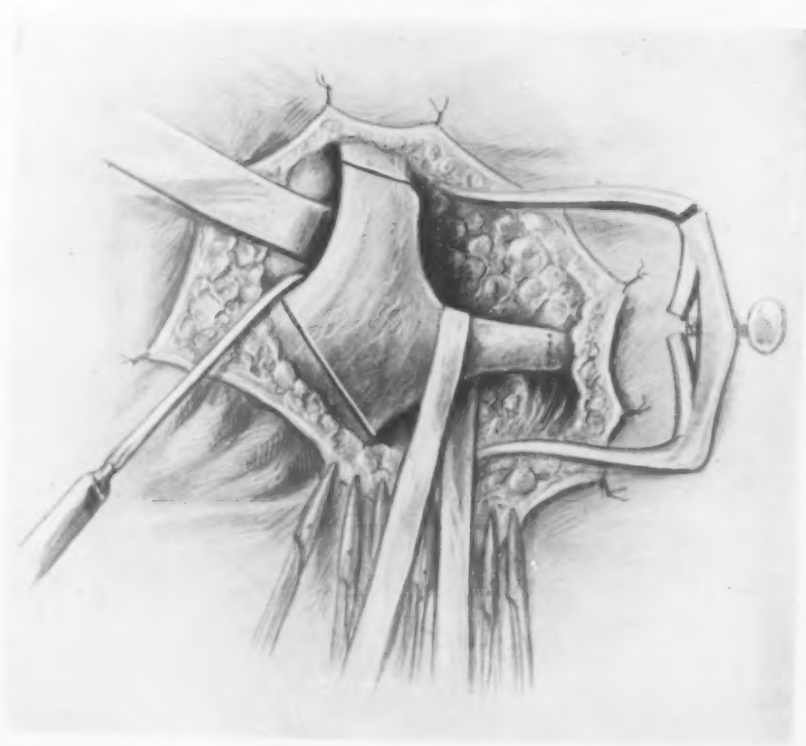


FIG. 5.—The isolation of the zygoma and malar bone. (a) Malar bone sectioned above and below. (b) Dotted line represents the point at which zygoma is divided with gigli saw from within outward, leaving the outer periosteum intact.

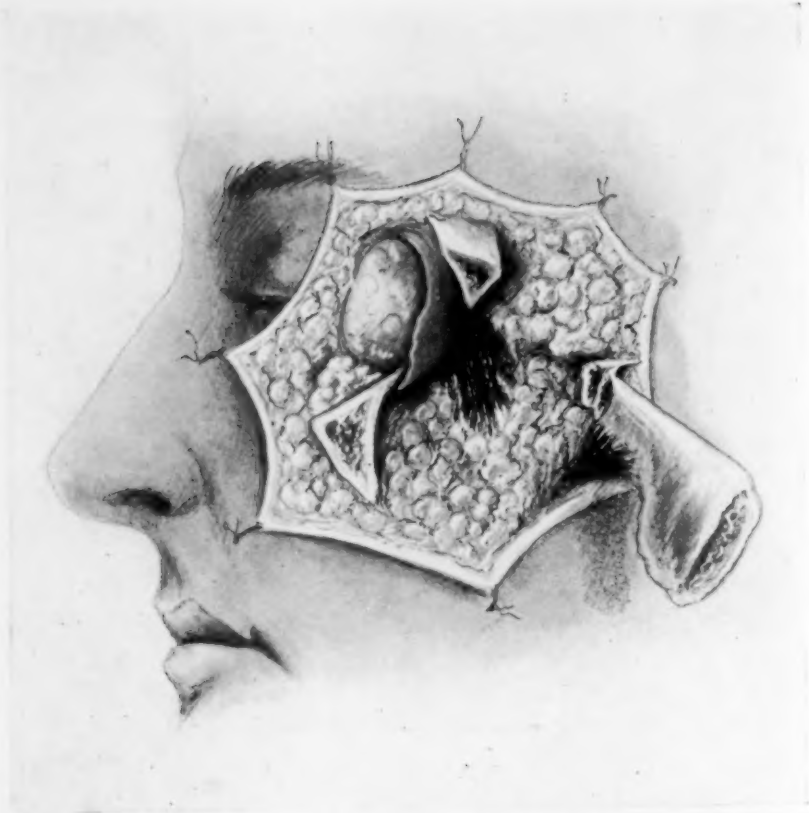


FIG. 6.--The Malar bone reflected backwards uncovering. (a) The fat and muscle tissue in the zygomatic fossa. (b) A portion of the orbital contents.

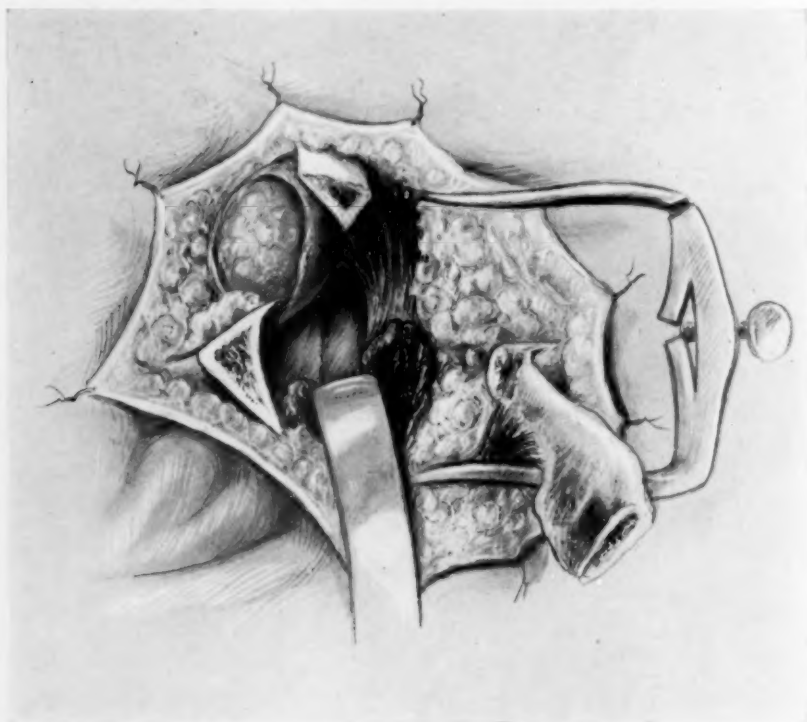


FIG. 7.--(a) Temporal muscle is retracted downwards exposing wall of antrum. (b) Internal pterygoid muscle above, intact.

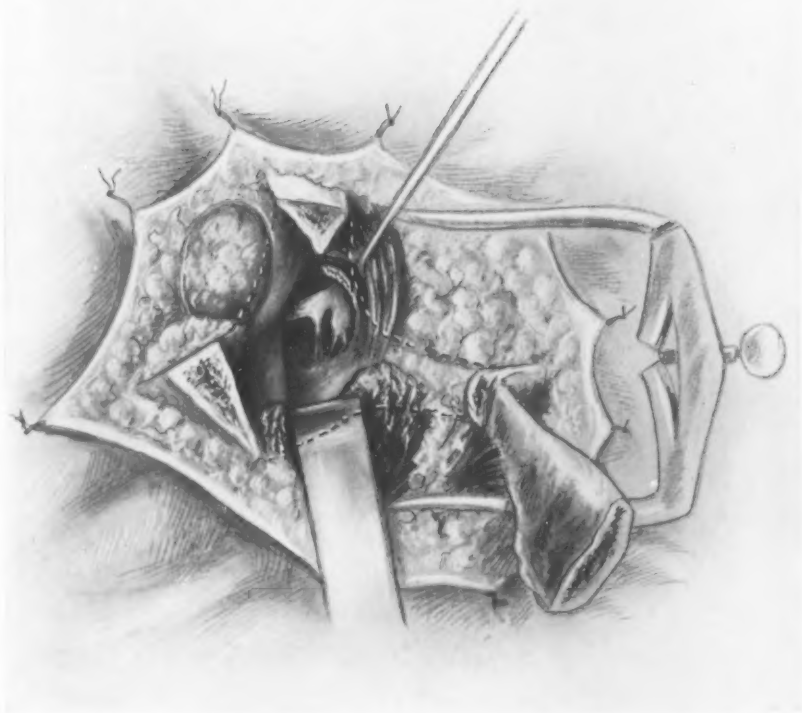


FIG. 8.—I. The internal pterygoid muscle is displaced upwards. II. Pterygoid plate has been removed in part with rongeur forceps. III. The sphenopalatine ganglion and the maxillary division of the trigeminal are exposed to view.



FIG. 9.--Photograph of patient after the author's operation for exposure of the sphenopalatine ganglion.

## SURGICAL APPROACH TO SPHENOPALATINE GANGLION

In the first three illustrations (Figs. 1, 2, and 3) will be seen the anatomical structures and relationships. The most direct route has been chosen as the most favorable and practical approach—a route that transverses first the zygomatic, then the sphenomaxillary fossa. To render accessible the zygomatic fossa the malar bone must be resected. Within the zygomatic fossa one encounters no obstacles not readily disposed of. All that one sees is a mass of areolar tissue, readily displaced, the posterior wall of the antrum, and the internal pterygoid muscle. To reach the sphenomaxillary fossa, in which is lodged Meckel's ganglion, a portion of the external pterygoid plate must be removed. Once within the sphenomaxillary fossa there are no structures to be seen except the maxillary division of the trigeminus, the artery that accompanies it, a mass of areolar tissue which surrounds Meckel's ganglion and its several branches.

### STEPS OF THE OPERATION

I. The incision (Fig. 4) has been designed with due regard for its cosmetic effect and to avoid important branches of the facial nerve. There are three limbs, one straight, in the direction of the zygoma, and two curved, following the lines of the supra- and infra-orbital ridges. With careful apposition of the margins of the wound the healed scar is quite inconspicuous. (See Fig. 9.) The branches to the orbicularis palpebrarum and the occipitofrontalis have not been disturbed.

II. Upon reflection of triangular flaps (Fig. 5) the malar bone is exposed and with a Gigli saw three sections of the bone are made: (1) Through the frontal process; (2) through the maxillary process, and (3) through the zygomatic process. To make sections 1 and 2, the Gigli saw is passed through the sphenomaxillary fissure. At section 3 the zygomatic process is sawed only partly through, the outer shell and the periosteum being left intact. Thus an attachment is conserved which prevents any dislodgment of the malar bone when replaced at the completion of the operation.

III. The malar bone reflected backwards (Fig. 6) at once exposes to view the zygomatic fossa and its areolar tissue. One sees in the anterior portion of the wound the external aspect of the orbit.

IV. A clearing of the contents of the zygomatic fossa is made now to expose the pterygoid plate (Fig. 7). This is accomplished by following closely the surface of the posterior wall of the antrum and displacing backwards and downwards the areolar tissue and the temporal muscle. Before the pterygoid plate is exposed to view the internal pterygoid muscle must be detached.

V. With rongeur forceps a portion of the pterygoid plate is removed and the contents of the sphenomaxillary fossa exposed. To find the sphenopalatine ganglion one should expose first the maxillary division, as it enters the orbit through the sphenomaxillary fissure, and follow it up to the ganglion. The ganglion itself is deeply placed in the sphenomaxillary fossa, close to the



sphenopalatine foramen. Surrounded by fat it is not readily seen, hence the necessity of following the course of the maxillary division as a guide.

Throughout the operation one does not see the internal maxillary artery. One might have anticipated troublesome hemorrhage from this source, but such is not the case. The only arterial trunk that one sees is the continuation of the internal maxillary artery in the infraorbital artery. The space in which one works is comparable in size to that in the approach to the Gasserian ganglion and I have found my illuminated retractor, so satisfactory in the Gasserian ganglion operation, amply illuminates the field.

## ATROPHY AND INACTIVITY OF PAROTID GLAND, FOLLOWING OPERATIVE OBLITERATION OF STENSON'S DUCT, IN CARCINOMA OF THE CHEEK.\*

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OF WHEELING, W. VA.

EFFORTS have been made, from time to time, to arrest the activity of the parotid gland or to reestablish by surgery the flow of saliva into the mouth, for fistula of Stenson's duct.

While these efforts have been ingeniously devised and directed along experimental lines, and many important contributions, both surgical and non-surgical, have been made, the very fact of the multiplicity of the procedures seems to indicate the difficulty in selecting a method as the operation of choice.

Deaver's<sup>34</sup> *Surgical Anatomy* describes the duct of the parotid as "running about a finger's breadth below the zygoma, or in a line drawn from the lower margin of the concha to a point midway between the free margin of the upper lip and the ala of the nose. It lies between the transverse facial artery above and the buccal branch of the facial nerve below. The duct runs over the masseter muscle, turning abruptly inward at its border, passes through a mass of fat overlying the buccinator muscle and beneath the facial vein, and pierces the buccinator muscle, to open into the mouth opposite the crown of the second molar tooth of the upper jaw."

The etiology of salivary fistulae is well known; how they may develop as a result of a trauma, or from faulty technic in the removal of a neoplasm, the opening of an abscess, or as a sequel to flap excision in facial autoplasty.

Salivary fistula may follow a destructive process due to carcinoma, lupus, rodent ulcer, actinomycosis, or syphilis, or from a pressure necrosis and infection arising from salivary calculi.

Agnew<sup>32</sup> describes a congenital salivary fistula in which the opening was on the anterior part of the helix of the auricular cartilage.

Mauclaire<sup>23</sup> reports eleven cases of duct fistula following dental abscesses, and three associated with the presence of foreign bodies, as wood and lead.

Schreiber<sup>28</sup> introduces a new etiologic factor, reporting a salivary fistula following a simple mastoidectomy. Such a misfortune, of course, coming from the parenchyma of the gland, demonstrates how this subject should seriously engage the attention of the operator who would deal with a tumor, phlegmon or mastoid.

An interesting factor with a definite bearing on the end result in the repair of a salivary fistula has been suggested by Tait,<sup>29</sup> whose original work in this field has won for him distinction. The normal length of the duct of the parotid is about 6 cm. and 0.3 cm. in diameter. The oral third contains the same bacterial flora as may be found in the mouth; hence it can be definitely seen that this source of infection offers an additional factor against successful surgery, particularly if there is any oral pathology.

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\* Read before the American Surgical Association, June 14, 1921.

The possibility of the relief of a salivary fistula coming through the obliteration of Stenson's duct by ligature was first suggested by Dupuytren,<sup>15</sup> accepted by Velpeau, and practiced by Viborg and Bramann, but their efforts were far from successful, due chiefly to the development of retention salivary cystomata, or infection with abscess formation.

**CASE REPORT.**—G. W., a man aged fifty-eight, was admitted to the writer's service in the Ohio Valley General Hospital in February, 1912, suffering with what seemed to be epithelioma of the right cheek. In the centre of the ulcer there was a salivary fistula. Extending out from the circumference of the ulcer there was a large area of cicatricial tissue, which was the seat of a dermatitis and otherwise devitalized from the overzealous use of caustics, pastes and Röntgen-therapy.

Luetic infection was definitely excluded, and on section the unhealthy neoplasm proved to be a cancer. There was no glandular involvement and otherwise the patient's health was good.

In planning the operation for the removal of the malignancy, the question of sidetracking the secretion of the parotid presented obvious embarrassment, due to the apparent destruction of a large part of the buccal portion of Stenson's duct. Flaps were designed by horizontal H-shaped incisions, radically removing the pathology, without involving the mucous membrane of the mouth. Further dissection and retraction of the posterior flap exposed the remnant of the masseteric portion of the duct, but the short proximal end precluded the possibility of following any of the operations suggested for diverting the flow of saliva into the mouth. Ligation of the duct with the chances of leakage, infection or cyst formation, with the probable defeat of the plastic repair, was not deemed wise. The remaining part of the duct was crushed with an angiotribe as far back as possible, and this short ribbon was brought through a stab-incision in the posterior flap onto the cheek and sutured to the skin.

The sole apology for this step in the technic was the hope entertained that one of two things might occur—either that the secretion of the parotid might find a new outlet far removed from the reparative work, or, however inconsistent, a happier result might be attained in the complete suppression of the physiological activity of the gland.

The skin wound was closed with horse-hair, and provision for drainage was effected by a stab-wound beneath the inferior maxilla, carrying a narrow rubber band.

The wound healed without interruption, there was at no time any further discharge of saliva from the obliterated duct, and there was an absence of any phenomenon of retention, or painful tension on the part of the gland.

Our reason bids us assent to the accomplishment of a fact, namely: The inactivity and atrophy of a gland following the operative obliteration of its duct; but the question may be raised, did the hoped-for changes in the histology of the parotid come as a result of our aid, or in spite of it?

Any further detail of the progress of the carcinoma, with the sequence of events, is not germane to this report; suffice to say that for almost three and a half years there was no sign of recurrence. But after that time the cicatricial tissue of the cheek, devitalized and scarred by repeated preoperative Röntgen-therapy and other remedial measures, offered little resistance to a rekindling of the disease. Despite the most skilfully applied X-ray cross-firing, radium, and electro-coagulation, the cheek, bone and meninges, in slow succession, yielded to the devastation, with the inevitable *exitus lethalis* in February, 1919. There was no autopsy.

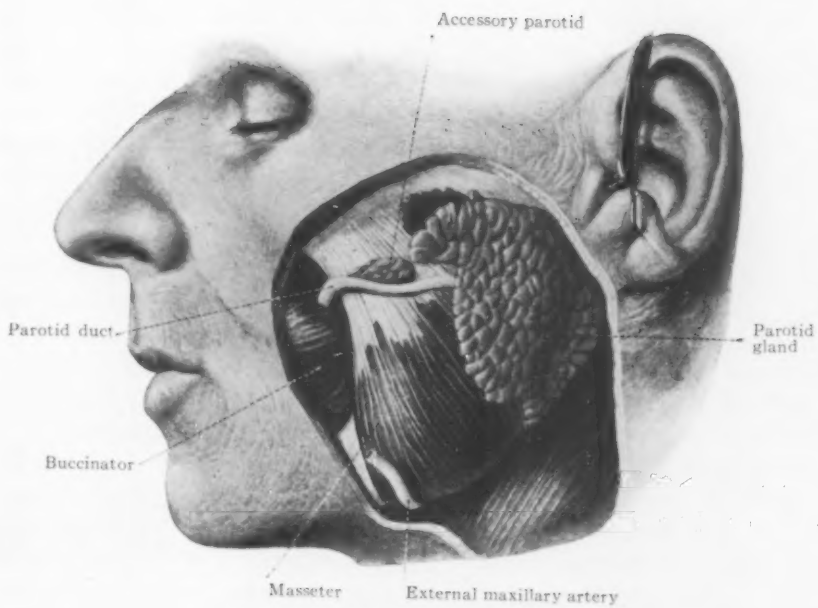


FIG. 1.--Parotid Gland and Stenson's Duct.  
From Sabotta's Anatomy, W. B. Saunders Co.



## ATROPHY AND INACTIVITY OF PAROTID GLAND

### COMMENT ON CHANGES IN THE GLAND

Very little has been written of the changes occurring in the parotid gland and its secretory function following operative obliteration of Stenson's duct. It is obvious that the subject needs further experimental investigation before we can depend on atrophy or involution taking place following this procedure.

Pietri's<sup>20</sup> observation leads to the assumption that atrophy comes about very slowly, this is particularly true following a non-infected fistula, while quite the contrary is the rule in cases of parotitis consequent upon traumatism, when the inactivity of the gland is rapid and permanent. In most of Pietri's cases the glandular tissue became sclerotic, adhering firmly to the tissue framework which before had acted as a support pure and simple. But this is an hypothesis, which the writer seems to think may be verified by the histologist.

In a personal communication from Frederick S. Lee, of the Department of Physiology of Columbia University, he found an account of some investigations by Maximow, in which in a dog the duct of the submaxillary gland and the duct of Bartholin (the chief duct of the sublingual gland) were ligated, and the dog was killed after thirty-one days. The ducts on the gland side of the ligature were found enlarged and filled with thick saliva. The glands themselves were considerably diminished in size, although the interlobular connective tissue appeared strongly hypertrophied. Microscopic investigation showed results very similar to those after section of the chorda tympani. There was apparently a paralysis and final disappearance of the mucous cells, while the serous cells, although changed, remained and continued to secrete.

Perhaps Cole's<sup>7</sup> suggestion may prove helpful, following the obliterative operation, in the use of radium or X-rays as a post-operative measure, in those exceptional cases where the transplanting of the duct is impossible.

Doctor Burnam, of Baltimore, in a personal communication, has described the changes in the parotid gland after radiation as striking, and quite different from those occurring in the ovary. All of the salivary glands a few hours after radiation swell enormously, and the patient presents the appearance of mumps. There is a cessation of saliva and consequently a drying of the secretions of the mouth, which lasts from a few days to two weeks after such treatment. This tendency to parotitis is the first change. If a tremendous amount of radiation is given there is gradual atrophy of the parenchyma of the glands; however, to accomplish this a very large treatment must be given. The parenchyma is replaced by proliferating fibrous tissue.

### REVIEW OF THE LITERATURE IN THE TREATMENT OF SALIVARY FISTULA

Pietri gives a résumé of the various early procedures, including the compression of the gland by Maisonneuer, caustics and agglutinants and the gold plate of Malgaigne. It is needless to say that these were of little efficacy and had their day, as did also compression of the carotid and ablation of the gland. The author speaks of the work of Molliere, of Lyons, who in 1884 endeavored to cause atrophy of the parotid by the injection of phenolated oil,



and how Cocchini gave preference to turpentine for the same purpose. These efforts are of interest historically, but are deserving of no comment.

Of the older operative procedures the one planned and successfully executed by DeGuise, and bearing his name, has been commonly accepted the operation of choice. It consists of the excision of the discharging sinus in the cheek, and the transfixation of the buccal mucous membrane at two points with a needle carrying either silk or wire. The ligature is tied in the mouth, and the seton effect with the consequent necrosis turns aside the parotid secretion in the natural direction.

This procedure is usually successful in the simple non-infected fistula, but, as so often happens, the discharge of saliva comes from a cancerous ulcer, which has destroyed a large part of the duct, and the removal of this malignancy becomes necessary by radical excision, before any thought can be given to the aberrant salivary flow. It is reasonable to infer that under these conditions it would be difficult to successfully employ any of the older methods, like the operations of Nicolandi, Langenbeck, Kaufman, or the ingenious oroplastic technic of Braun.

#### REVIEW OF EXPERIMENTAL WORK

Ferrarini's<sup>16</sup> work included a series of operations on dogs, which were interesting. On one side simple ligature and resection of Stenson's duct was done, on the other side ligature of duct and suture of parotid and submaxillary glands. After three months he dissected out Stenson's duct and injected colored gelatine into the central end. On the side where the gland had been united the gelatine passed from the parotid into the submaxillary. In dogs long operated the inflow was so easy that the gelatine could be made to pass out of Wharton's duct and vice versa.

Histological examination of several sections showed that an intimate union had taken place between the glands of the one side; on the other side the glands showed typical atrophy processes, whereas the parotid which had been joined to the submaxillary had preserved its form, volume, and for the most part its structure unchanged.

The operation on man—done only on the cadaver—is described as free from difficulty. The usual section for submaxillary removal is made, being carried about 2 cm. further upward and backward along the border of the vertical ramus of the mandible. The submaxillary capsule is incised and the gland completely mobilized. Behind the angle of the mandible the lower end of the parotid lobe is isolated, and, when necessary, the small aponeurosis between the angle of the mandible and the anterior border of the sternomastoid is divided. The glands are then easily approximated over a wide area. A small part is removed and the cut edges sutured, the parenchyma and the capsules being joined separately. Ferrarini expects the operation will be clinically successful in stubborn cases of duct fistula.

Tait<sup>20</sup> conducted three sets of experiments on dogs, cats, and rabbits. The first set consisted in double ligation and resection of 1 cm. of Stenson's

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duct in either the inner, middle or outer third, the resected tissues being tested bacteriologically in each case; the second set consisted of ligation of the duct without resection; in the third set a double fistula was made in the outer third and then treated by double ligation and section of the duct in its inner third. From the results of these experiments he reaches the following conclusions:

"Atrophic sclerosis of the parotid gland follows obstruction of Stenson's duct.

"Its extent is in direct proportion to the degree and duration of obstruction.

"The addition of an element of infection may hasten the hyperplastic process.

"Distention of the duct may persist long after the gland has undergone almost complete fibrous atrophy.

"Fistula of Stenson's duct may be permanently cured by double ligation and section of the duct as close as possible to the gland.

"Operations on the bacterially rich outer third of Stenson's duct are much more frequently followed by fistula than are similar interventions on the inner third of the duct.

"The effects of incomplete obstruction or stenosis of the salivary ducts are frequently found in the parotid and submaxillary glands, where, by simulating malignancy, they may lead to grievous mistakes in surgical therapy."

### SURGICAL TREATMENT

The article by Dieulauf<sup>28</sup> and Pietri<sup>29</sup> in the *Annals of Otology*, December, 1918, reviews some of the earlier methods of treatment. The Paris Thesis, by Rousseau,<sup>27</sup> included in the Bibliography, gives no additional data of importance.

Aigrot<sup>1</sup> presents an interesting discussion of the rôle of the auriculo-temporal nerve, and a report of the anatomical studies on its distribution in the ox, horse, pig, sheep, dog, and man, with a description of Leriche's procedure and the indications for its use.

Benedict<sup>2</sup> gives the history of a case of gland fistula caused by syphilitic abscess. The external opening was freshened and sutured, with recovery.

Berteaux<sup>3</sup> reports the case of a girl of eleven who had had a duct fistula for seven years because of an incompletely healed wound from a dog bite. The duct anterior to the fistula was not viable, and he concluded to lead the central portion into the mouth cavity. It was dissected out for about a centimetre. An opening was then made through the cheek and two linen threads attached to the end of the freed portions of the duct were passed through the opening. The threads were then sewed into the lips of the buccal wound. The suture was made so as to maintain the opening of the duct. The external wound healed in twelve days and the patient was discharged eighteen days after the operation, with a buccal fistula functioning perfectly.

Carwardine<sup>4</sup> dissected out the branches of the facial nerves which pass through the parotid. These were held up with catgut and the whole gland removed. He used small sharp scalpels. There was temporary facial paralysis, but in a couple of months there were twitchings, and in four months some movement. A year afterward the patient had good control of the facial muscles and very little difference between the two sides was apparent.

Cole\* treated two cases by an ingenious reparative operation. The general principle adopted in this operation was that "if the duct will not reach the mouth cavity, the mouth cavity must be made to reach the duct." A curved incision was made with convexity down, and a small flap resected upwards; this revealed the duct, and a small lateral hole in the duct marked the limit of patency. The duct was freed, its terminal portion resected, and two very fine catgut traction sutures were passed through its walls. The mucous membrane, covered by buccinator, was then made prominent immediately in front of the masseter by means of a small swab pressed against it from inside the mouth, and a small longitudinal incision was made through it into the mouth. The masseter was nicked at its anterior border and the margins of mucous membrane stitched to the deeper margins of the wound. Through the aperture thus made the stay sutures were passed and the duct was gently pulled into the funnel-shaped extension and the extension cut off from communication with the exterior by catgut sutures. The skin was sewed up; drainage through a small stab incision. Each stay suture through the duct was then made to take a good hold of mucous membrane inside the mouth, so that when tied the duct was secure in place. In both cases slight supuration with discharge of saliva occurred about the tenth day, but communication with the mouth was well established and good healing occurred in a few days. Both cases were discharged cured in three weeks.

Hamilton" operated on a patient with a fistula of several years' standing, enlarging the opening, and curetted out from a cavity the size of a hazel nut "some starchy gelatinous secretion, together with shell-like fragments of calculous material" lining its wall.

The anterior part of the duct was not visible; the posterior part very short.

A hæmostat was forced from the cavity through the gland and the mucous membrane cut over the point of the forceps. The channel thus formed was enlarged by opening the forceps widely. A flap was cut one-half inch wide at the base just anterior to the artificial buccal opening and tapering slightly to its tip, which was posterior to the angle of the mouth. The flap was slightly less than one-eighth inch deep. The hæmostat was again pushed through the channel and the tip of the flap seized and drawn into the fistula cavity, the mucous membrane being superficial. It was sutured to the gland surface by three fine silk sutures. The external margins were pared and sutured and the buccal mucous wound sutured. A rubber drain was inserted into the new opening. Complete cure.

Jennings" described a razor cut with subsequent scar which caused occlusion of the duct and collection of saliva in tumor-like lump under the skin. A cyst-like cavity at the edge of masseter muscle was found. A bougie passed from the mouth one and a half inches up the duct which was severed. A rubber tube was inserted into the severed end and also into the central end which opened into the cavity. A continuous chromic gut suture was put in so as to obliterate the greater part of it, the skin wound left open, dressed with sterile gauze and sealed with collodion. The wound healed in about two weeks. The tube was in place on the tenth day; on the eighteenth day it had disappeared. The duct was patent two months after operation.

Leriche" reported a case in which he abolished the physiological activity of the parotid by avulsion of the auriculo-temporal branch of the inferior maxillary nerve (Fig. 2). Dieulafe," in his endorsement of Leriche's operation, mentions eleven cases in which this method was successfully employed.

The operation is comparatively simple, but it must be remembered that it does not always result in an immediate cessation of the flow of saliva. In the cases reported, in only one was the cessation immediate; in all others two to

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eight days elapsed, in most cases five to six days, before the secretory activity of the parotid and the flow of the saliva ceased entirely.

Weitz<sup>21</sup> reports one case in which the fistula had persisted for more than twenty years, treated by Leriche's method. The salivary secretion ceased at once, and did not reappear. He notes also Tromp<sup>22</sup> had operated on three cases successfully by this method.

Cole<sup>7</sup> condemns Leriche's operation, comparing it to the plumber who would repair the leaking pipe by cutting off the water supply of the house.

Mothersole<sup>23</sup> reported a patient who developed a fistula after an operation for removing a neoplasm. The amount of scar tissue surrounding the opening excluded most methods of operating, so the author dissected up a strip of mucous membrane one and one-quarter inches long and one-third inch broad, with its long axis horizontal and its front end near the mouth of the parotid duct. He then bored a hole through the cheek just in front of the fistula and dilated it so that the flap could be brought through the opening. He then dissected up the surface of the scar on the cheek, and removed all but a small collar of tissue surrounding the fistulous opening above, behind, and below. To this he attached the free end of the flap by a few interrupted catgut sutures. This

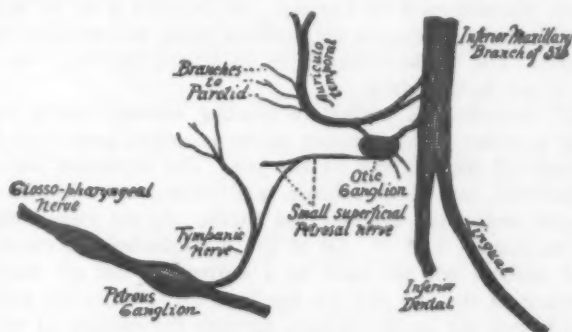


FIG. 2.—Leriche divides the auriculo-temporal branch of the inferior maxillary division of the fifth cranial nerve, in his operation for fistula of Stenson's duct.  
From Howell's Physiology, W. B. Saunders Co.

made an epithelium lined track from the parotid gland to the mouth cavity. He dissected from the neck, just below the horizontal ramus of the jaw, a flap of skin left attached at its posterior part, rotated it through a quarter circle and covered the raw surface on the cheek with it. The gap left was closed by interrupted sutures except a small triangular bit at its widest part. The wound had healed in a fortnight and all the parotid secretion passed into the mouth. Sixteen months later a probe passed easily through the duct.

### NON-SURGICAL TREATMENT

Cole<sup>8</sup> contends that fistulae of the gland and incomplete fistulae of the duct tend to heal without treatment. If treatment is delayed the application of radium or X-rays is indicated. He writes: "Gland fistulae and incomplete fistulae of the duct have never failed to respond to radiations."

The radium treatment consists in exposures to a penetrating radiation from 250 mg. of radium in platinum tubes of a thickness of about one-half mm.; 3 mm. of lead were also used to cut off the hard Beta rays; tubes enclosed in rubber and several layers of lint were used on the skin. Exposure of three to four hours was given each skin area, those with considerable induration of tissue

receiving a longer exposure than others. In a number of patients X-rays were combined with the radium, small doses being given at short intervals, a 2 mm. aluminum filter being used.

The title of Kouindjy's<sup>19</sup> article indicated treatment of salivary fistulae by massage and the application of hot air. The original article was not available.

Moreau<sup>20</sup> treated one case with silver nitrate and iodine alternately. Care was taken that the orifice was not closed too quickly. The treatment was satisfactory after a month.

Pietri<sup>21</sup> thinks that rather than change the course of the saliva by surgical procedure, it would be more logical to try to lessen its production by absolute rest. Through the agency of what he calls a mask, which is not unlike the Barton bandage, he immobilizes the jaw, at the same time suppressing all gustatory sensation; enforcing a liquid diet for several weeks, with tube feeding and imposing on the patient absolute silence. Thirty-eight cases were successfully treated by this method.

The original of Stropeni's<sup>22</sup> article is not available, but according to the abstract in the J. A. M. A., 75:138, 1920, his treatment consisted of blocking the third branch of the trigeminal nerve by injecting alcohol. This proved as efficient in curing the flow of saliva from a fistula as resection of the auriculo-temporal nerve recommended by Leriche. He injected 3 cc. of alcohol at the base of the skull, corresponding to the foramen ovale, and repeated this injection three days later. The fistula continued to suppurate, but there was no further secretion of saliva in the gland.

Kouindjy<sup>23</sup> describes his method of treating salivary fistula, as illustrated in one case of a soldier with a fracture of the mandible, badly consolidated, and a salivary fistula of the left side of the jaw. The treatment was begun "by massage, superficial, and deep rubbing, and centripetal vibrations from the periphery to the centre, not touching the fistula. At the same time the facial cicatrix was massaged. \* \* \* All of the massotherapeutic manœuvres were executed first without hot air, later by a current of hot air over the entire cutaneous surface of the jaw and the fistula itself. Finally the current of hot air was turned upon the buccal surface, through the opening of the mouth, in such a way as to bring it in contact with the internal border of the fistula." In order to avoid burning or pain, the application of hot air was interrupted every two or three seconds. (Temperature of air, 37.9° to 30° C.) The treatment was begun August 20, 1918; improvement was noticeable by September 26th, and the fistula was completely obliterated by December 17th.

The action of massage and hot air on the fistula, Kouindjy explains as follows: The hot air causes a hyperæmia that induces a local change that may be compared to a caustic action. In addition it has an analgesic action on the tissues and causes progressive drying of the secretions. This last effect can be compared to resection of the auriculo-temporal nerve. The action of massage is mechanical and reflex. The mechanical action has a favorable effect on the circulation and the reflex action on the terminal nerves. It also increases the nutrition of the tissues.

From this study and out of the abundance of an interesting literature, including experimental, surgical and non-surgical, we may briefly conclude:

1. That by crushing the duct of the parotid there may follow histologic changes leading to an atrophic sclerosis, with suspension of the activity of the gland.
2. It is fair to assume that this condition is influenced by the use of radium alone or combined with the X-rays, resulting in a replacement of the gland by a proliferating fibrous tissue.



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3. Further experimental evidence is wanting before we may depend on operative obliteration of the parotid duct to arrest the flow from a salivary fistula.

4. Fistula of Stenson's duct has been permanently cured by double ligation and section of the duct as close to the gland as possible. (Tait.)

5. Leriche and his followers have arrested the physiological activity of the parotid by avulsion of the auriculo-temporal branch of the inferior maxillary nerve.

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## AN ANALYSIS OF 102 CASES OF TUMORS OF THE BREAST\*

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THE American Text-book of Surgery, published in 1903, states that "about 83 per cent. of all mammary tumors are carcinomata, while the remaining 17 per cent. are sarcomata, adenomata and cysts." In 1911 my son, Dr. Nathan Winslow,<sup>1</sup> and I, tabulated a series of 100 cases of lesions of the breast, occurring in the University Hospital, Baltimore, with the following result: sixty-three were carcinomata, three sarcomata, twenty fibro-adenomata, one peri-canalicular myxoma, five cystic fibro-adenomata, two galactoceles, three tubercular mastitis and three abscesses. Of these ninety-nine were females and one a man, with a fibro-adenoma. Eighty-eight were of the white race and twelve of the colored.

The question of the incidence of carcinoma in comparison with all other tumors of the breast seems still to be unsettled; thus Finney<sup>2</sup> places the proportion as 80 per cent. cancer; A. P. C. Ashhurst<sup>3</sup> as 70 per cent. malignant and Da Costa<sup>4</sup> says malignant tumors of the mammary gland are ten times more common than innocent tumors. Dr. Miles F. Porter,<sup>5</sup> writing in 1919, says that of seventy-seven cases of neoplasms of the breast observed by him personally, forty-nine, or 63.63 per cent., were malignant and twenty-eight, or 36.37 per cent., were benign. On the other hand, Bloodgood<sup>6</sup> gives the percentage of benign to malignant lesions of the breast, as observed at the Johns Hopkins clinic, as gradually rising from 32 per cent., in the first decade after the opening of the hospital, to 59 per cent. in the three years immediately preceding his report; and this he attributes to the education of the profession and the public, through which patients are referred to the clinic at an earlier date than formerly.

As this statement is at variance with the usually accepted opinion, we have gone over the records of the University Hospital for the three years 1917, 1918 and 1919, to ascertain if there has been any material change in the statistics of breast lesions as they have been observed in this particular institution since the publication of our report in 1911. During these three years 102 patients were admitted to the hospital, with lesions of the breast of various kinds. Of these sixty-one were carcinomata, three sarcomata, eighteen benign solid growths and twenty benign cystic growths. Ninety-nine were females and three males. Of the women ninety were white and nine colored. The men were white and had non-malignant neoplasms. Eighty-eight were married, ten single and in four the social condition is not recorded. The left breast was involved in fifty-six cases, the right in forty-four, not mentioned two. Both breasts were involved in one case, the lesions being benign. Ninety-two cases were subjected to operation, of whom three died; one of

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pneumonia, one myocarditis and one acute dilatation of the heart. Six cases were inoperable and three refused operation. Fifty-nine and eight-tenths per cent. were carcinomata, 2.94 per cent. sarcomata and 37.26 per cent. benign. The length of time that elapsed between the discovery of a tumor by the patient and the application to the surgeon for relief varied from one week in two cases to forty-nine years in one; the largest number of cases coming under surgical care at the end of one year. The ages of the patients varied from nine years, in the case of a negro girl who was operated on under a diagnosis of fibro-adenoma, to seventy-two years in two cases of carcinoma.

*Carcinoma.*—The cases of carcinoma were sixty-one in number, or 59.8 per cent. The largest number of cases came under observation in the fifth decade of life. Six occurred before thirty-five years of age and two between twenty and thirty. The youngest was twenty-three years old, and was operated on under the diagnosis of fibro-adenoma, but the pathological report was "cystic papillo-adenoma, undergoing early malignancy." Among the cases tabulated in our previous report was that of a girl of seventeen, with a fibro-adenoma undergoing malignancy. Two women, aged seventy-two, were operated on, one dying in about three weeks with myocarditis and the other died a year later with a recurrence.

The carcinomata were subdivided into simple carcinoma twenty-eight, scirrhus eighteen, scirrhus with colloid degeneration one, scirrhus with hyaline degeneration two, medullary one, adenocarcinoma three, cystadenocarcinoma one, cystic papillæadenocarcinoma one, cystic carcinoma one, suppurating carcinoma one. Fifty-seven of the women were married, two single and two not stated. The right breast was involved in twenty-seven, the left in thirty-three cases.

The tumor was located in the upper and outer quadrant in twenty-two, upper and inner four, lower and outer four, lower and inner one, central three, general eight, the rest not recorded. For some reason unknown to me the cancerous growth is generally located in the upper and outer quadrant. In my personal experience cancers situated in the upper and inner quadrant are much more unfavorable as regards permanent cure than those located on the axillary border.

In January, 1917, a lady, aged forty-eight, consulted me for a lump in the upper and inner portion of the left breast. The growth had been in existence six years and had increased rapidly during the preceding six months. There were marked axillary metastases. A radical operation was done and she made a speedy recovery. One year later she returned with a considerable mass in the sternum, opposite the second and third costal cartilages. I excised a considerable portion of the sternum, with the overlying tissues, leaving a large square hole leading into the anterior mediastinum. The internal mammary artery was cut and bled freely before it could be ligated and the left pleural cavity was opened and air sucked in. She developed an empyema, which was drained posteriorly, and she recovered, but died in November, 1919, of general carcinomatosis.

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In October, 1917, a colored woman, aged forty-two, appeared with a fairly movable tumor, as large as a hickory nut, that had been noticed about six weeks. This was also located in the upper and inner periphery of the left breast and was supposed to be an adenofibroma until a frozen section revealed it to be a carcinoma. The breast, muscles and axillary glands were removed. In the summer of 1919, she returned with a metastasis, very similar to the one mentioned above; in the sternum. She elected to try radium, under the application of which the swelling subsided somewhat. She is still alive but is failing rapidly.

The growth was stated to have been adherent to the skin or muscles in forty cases and in only ten was it recorded that it was not attached to either.

The axillary glands were recorded as not palpable in three cases and in two the supraclavicular glands were to be felt. Duration of the tumor—three weeks one, seven weeks one, two months three, three months three, four months three, five months two, six months four, seven months one, eight months one, nine months one, ten months one, one year five, one and a half years one, two years three, six years three, ten years one, twelve years one, twenty years one, twenty-two years one, forty-nine years one.

Many more married than single women have cancer of the breast, but this depends more on fecundity than on the social condition. Trauma also seems to play only a small part in the production of cancer of the breast; and in only four cases was there any history of an injury.

Pain, also, is not a frequent concomitant of mammary cancer, and in only a few of our records is it stated that pain or tenderness were present.

One woman had had bleeding from the right nipple intermittently for one and one-half years. The nipple is stated to have been retracted in twelve cases, not retracted in eleven, and stiff in one.

There were six cases of carcinoma of the breast in negro women. It is a mistaken idea that negroes are to any large extent immune to cancer.

Metastasis to the skeleton is only occasionally observed and the only bone involved in this series, except the two in which the sternum was the seat of recurrence, was the ilium. When remote metastases occur the usual locations are the spinal column, the femur or the humerus.

*Sarcomata*.—There were three cases of sarcoma, or 2.94 per cent. They were all white women and married. Their ages were twenty, fifty-four and sixty-three. One had been in existence two years and one only two months. In all the left breast was affected.

The pathological classification was sarcoma one, myxosarcoma one, fibromyxosarcoma one. No metastases were mentioned in any of these cases. Radical removal was done in all, except that in one case the pectoral muscles were not ablated.

*Non-malignant*.—There were thirty-eight cases of non-malignant tumors, or 37.26 per cent. Women, thirty-five; men, three; white, thirty-six; colored, two. Twenty-seven were married and eight single. The ages ranged from nine to sixty-six years. The right breast was affected in sixteen cases, the left in twenty-one, and in one both breasts were involved. The location of the

growth is stated in only sixteen cases, and of these, eleven were situated in the upper and outer quadrant. The size of the tumors varied from that of a pea to that of an egg or lemon. Three cases had had tumors of the breast removed previously. The lesions were classified as follows: Fibro-adenomata fifteen; of these two occurred in males aged thirty and forty-two, respectively; fibromyxoma one, in a male aged sixty-six; intracanalicular fibroma, one; cystic fibro-adenomata, twenty; chronic hyperplasia, one.

Two cases were operated on under the supposition that they were adenocarcinomata, but the microscopical examination showed them to be fibro-adenomata. A negro girl, nine years old, who had a considerable enlargement of the left breast, but not of the right, was supposed to have a fibro-adenoma and the breast was amputated, but the pathological report was "chronic hyperplasia."

In only two cases was there a history of trauma. Most of the tumors were freely movable and there were no glandular metastases. Pain was absent in most cases, but in one attention was first called to the breast by pain, when a lump was discovered. The time the tumor had been noticed by the patient before coming to the hospital for treatment varied from one week to five years, only six being recorded as having been less than one year in existence.

#### CONCLUSIONS

1. From a consideration of these and other cases, and from the published statistics of other writers, I am still of the opinion that carcinoma is the predominant neoplasm of the mammary gland and that it occurs in from 60 to 65 per cent. of all mammary tumors.

2. While it is probable that breast tumors are coming under observation earlier than was formerly the case, nevertheless, in the hospital with which I am connected there has been no marked difference between the time at which this series of cases came under surgical care and that of the series collected in 1911.

3. Sarcoma occurs in about 3 per cent. of tumors of the breast. This condition is malignant and should be treated in as radical a manner as a carcinoma.

4. Non-malignant neoplasms occur in about 35 per cent. of all cases. In my opinion no woman should be allowed to harbor a neoplasm in her breast, whether it be benign or malignant, or whether she be young or old. Sooner or later benign tumors tend to become malignant; and the time to remove them is while they are still benign. One woman in this series had had a tumor in her breast forty-nine years.

5. In my opinion it is unsafe to trust to the macroscopic diagnosis of tumors, however skilled one may be; and that a microscopical examination of frozen sections should be made, at the time of operation, of all neoplasms of the breast of which there is any doubt as to their innocency or malignancy.

6. Should the breast of a child approaching puberty be amputated for a



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uniform enlargement of that organ or should we delay operation until it is evident that the enlargement is or is not due to physiological conditions?

7. The question of the proper treatment of primary or secondary tumors of the sternum is open to debate. Should extirpation be undertaken or should they be treated with radium or X-rays?

Quénu and Longuet<sup>7</sup> say in regard to secondary tumors of the sternum: "These interest the surgeon but little; it is evident that he ought not to touch a lympho-sarcoma of the mediastinum involving the sternum, and the same is true of cancers of the breast involving the sternum. Nevertheless, one may be induced, by necessity or by foresight, to attack the sternum when in the course of an operation for cancer of the breast or of a recurrence of the cancer, a sternal adenopathy is discovered."

Finney<sup>2</sup> also says: "Whether it is ever justifiable to open the anterior mediastinum or to remove ribs and parietal pleura cannot be settled arbitrarily."

Rodman,<sup>9</sup> while condemning partial operations for cancer of the breast as worse than useless, advocates very radical operations in some instances. In one case he excised a portion of the sternum and several ribs with a part of the parietal pleura. The woman recovered from the operation and lived nearly three years afterwards. Dr. Emmett Rixford,<sup>10</sup> in an excellent paper read before this association in 1905, reports three personal cases in which he excised portions of several ribs and portions of the sternum for recurrent carcinoma; and one case of sarcoma of the clavicle, first rib and sternum, with a large mediastinal tumor, in which he resected the clavicle, a portion of the first rib and a part of the upper end of the sternum. In one of these cases three separate resections of the chest were done. All recovered from the operation and life was materially prolonged in most cases.

Herman Mynter<sup>11</sup> reports an excision of the sternum for melanosarcoma of that bone. A girl, aged twenty, had a tumor, the size of one-half an orange, extending from the second to below the fifth rib. It was of eleven months' duration and there were metastases in both axillæ and in both supraclavicular fossæ. The tumor was immovable, with an indistinct sense of fluctuation. The skin was normal in color and not adherent. November 14, 1890, under ether anæsthesia, a "U"-shaped incision was made, convex downwards; the tumor was exposed and scraped out and the bone cut away with bone pliers. The pericardium was exposed for six square inches. The highest temperature was 101 and the wound had healed in ten days.

This was neither a secondary tumor of the sternum nor connected with the mammary glands in any manner, but it was apparently a very malignant growth of the sternum, which was successfully removed; though why it was thought wise to do an operation of such magnitude and gravity on a woman who had extensive glandular metastases in both axillæ and in both supraclavicular fossæ I am at a loss to understand.

8. Equally as serious, and even more frequent, is the extension of cancer from the breast to the ribs. What should be done in such cases? A. P. C. Ashhurst<sup>12</sup> says: "Even fixation to the chest wall does not necessarily contra-



indicate excision; the portion of ribs invaded may be removed." The only case in which I have removed ribs for recurrent carcinoma terminated disastrously, but I find quite a number of operations, reported by Fellows of this association, that have been at least measurably successful. Thus Rixford, in the article previously mentioned, credits Stillman with the removal of 5 cm. of the fourth and fifth ribs for recurrent carcinoma, with a rapid and uneventful recovery, the patient being in perfect health two years subsequently. Similar operations have been reported by Dr. Elsworth Eliot,<sup>13</sup> Willy Meyer and Lucius W. Hotchiss with encouraging results. I think, therefore, that, while in most cases of direct or secondary involvement of the ribs no operation should be undertaken, in some cases it is justifiable and proper to resect the ribs and the underlying pleura.

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## DIAPHRAGMATIC HERNIA; THE THORACIC APPROACH\*

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THE essential purpose of this communication is to call attention to a type of diaphragmatic hernia occurring in the pedestrian child by the passage of an automobile wheel over the upper abdomen, and to consider the methods of cure by operation.

A review of the literature on hernia of the diaphragm shows a substantial and progressive increase in the number of cases discovered and cured. It is evident that internists and röntgenologists in particular are on the alert for it. The unexpected is less frequently met at operation and there is abundant evidence to indicate that the mortality figures have been reduced strikingly within a decade.

Scudder<sup>1</sup> found fifty-three operated cases recorded up to 1911. Frank<sup>2</sup> carefully reviewed the literature in 1919 and could add only forty-one additional cases over a period of about seven years. From 1918 to 1920 inclusive, ninety-six cases have been reported. It is probable that in my search of the literature there has been some overlapping of the series recorded by Frank. Nevertheless, the rapid increase in the number of operations for this deformity is very manifest. Of the ninety-six cases collected forty-three were the results of battle casualties. There can be no doubt that the number of cases treated and not reported is considerable. The number of cases observed among children is singularly small, five in all. Three were of congenital origin and two reported in this article were caused by external violence.

In diaphragmatic hernia intestinal obstruction is the outstanding factor of risk to life. In Scudder's series the surgical mortality was 75 per cent., essentially because of intervention during strangulation of the transposed viscera. Unlike this accident in other types of hernia the process is concealed and the symptoms and physical signs somewhat strange. Hence, delay is the rule and the mortality exceedingly high. The operative mortality in any series depends upon the number of cases encountered during acute intestinal obstruction. Warren<sup>3</sup> reported eight cases treated surgically during ten years at the London Hospital. Only one lived. Seven were operated upon in the presence of acute obstruction.

From current reports and observation it appears that most patients, even children, withstand surgical intervention for repair of the diaphragm remarkably well. The general mortality after operation in the non-strangulated type of diaphragmatic hernia averages below 10 per cent. It should be less than 5 per cent. when experience is enlarged and the methods of intervention best suited to each case are more clearly defined.

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*Innervation of the Diaphragm.*—The primitive mammalian diaphragm is derived from the muscular myotomes which invade the septum transversum. It becomes a muscular partition with an important innervation. In its descent from its position under the fourth and fifth cervical segments the muscle buds carry their nerve, the phrenic, with them. The entire nerve supply of this musculo-fibrous septum has been a subject of absorbing interest to anatomists and physiologists for more than a century. More recently the attention of surgeons has become centred upon a consideration of this phase of the subject because of the congenital defects and injuries of the diaphragm which require operative measures for repair.

The left phrenic nerve, that in which we are particularly interested because hernia is at least eight times more common on the left side, pursues a general anterolateral course and pierces the diaphragm at the junction between the musculature and the central tendon (Fig. 1). Under cover of the peritoneum, it splits into an anterior, a lateral and a posterior branch. The anterior supplies the muscle of the left sternal portion and the anterolateral part of the left costal portion. The lateral branch supplies the corresponding part of the left costal section. The posterior branch is distributed to the left lumbar region of the muscle.

In its descent to its permanent level according to Keith,<sup>4</sup> the diaphragm receives muscle tissue from the transversalis and the rectus sheaths, taking with it an innervation from the thoracic segment of the spinal cord. This innervation of the human diaphragm from the lower intercostal nerves was discovered almost a century ago by several of those accurate observers, the dissecting anatomists. Meckel<sup>5</sup> described it in 1817. Joseph Swan<sup>6</sup> gave a very explicit account of this innervation in 1830. He described filaments to the diaphragm from the sixth, eighth, ninth, eleventh and twelfth intercostal nerves.

The careful histological studies of Pansini,<sup>7</sup> who was the first observer to reinforce the dissection method by histological examination, and of Cavalie, from a dissection of twenty human diaphragms,<sup>8</sup> confirmed the work of the early observers and proved beyond doubt the existence of an intercostal innervation to the diaphragm. Keith<sup>9</sup> has shown that in an African toad, the *Xenopus*, the two nerves which represent the phrenic nerves of mammals come off from the second and third spinal nerves; these two nerve branches pass respectively to the ventral part of the amphibian diaphragm and to its dorsal portion. In all birds, except the ostrich, the innervation of the diaphragm is from the intercostals. The ostrich is the only bird which has retained part of its phrenic innervation. Thus, in respect of the nerve supply of the diaphragm, mammals have retained the cervical innervation of their amphibian ancestors. Except its rim, which is supplied by filaments from the seven lower intercostal nerves, Kidd<sup>10</sup> believes that the entire diaphragm derives its pain-conducting nerves from the phrenics. He is of the opinion also that the thoracic innervation is both sensory and motor and comes into action during deep and forced inspiration.

## DIAPHRAGMATIC HERNIA

Operations for hernia of the diaphragm have been carried out with little consideration of the permanent, partial functional derangement of the affected half of this septum from rupture, especially that form which results in lacerations of considerable degree. In rare cases where the nature and extent of the defect or laceration is such as to involve one or more of the large branches of the phrenic nerve, it is inevitable that the functional capacity of the affected side of the diaphragm rarely, if ever, returns to normal. In the case to be recorded the diaphragm is shown to have a higher position than normal months after operation. This would indicate defective innervation and a high diaphragm comparable to a moderate degree of eventration.

That part of the diaphragm which is essentially muscular forms its rim. The central portion is fibrous. Under these circumstances, and from a surgical viewpoint, the complete innervation of the diaphragm becomes an important consideration. Admitting that the main nerve supply is from the phrenic, the preservation of an associated innervation such as it derives from the intercostal nerves is a factor to be considered in the transthoracic operation.

*Methods of Operation.*—Both the clinical and structural picture of diaphragmatic hernia varies widely and the method of operation best suited for its repair necessarily remains a problem to be decided upon the evidence in each case.

There are two methods for approaching the diaphragm, the abdominal and the thoracic. Most of the operations reported by American and British surgeons show a decided preference for the abdominal approach while the French favor the thoracic operation. The thoracic cavity is entered so seldom in comparison with the abdomen that, when a choice of approach is to be made, it naturally requires strong inducements to divert the average surgeon from the transperitoneal approach. Then again, so dissimilar are the cases of diaphragmatic hernia in certain particulars that no one plan of approach is best suited to overcome all barriers. Consequently another method which combines the thoracic and abdominal approach has been practiced by Auvray<sup>11</sup> and other French surgeons. It consists of a resection of the ninth rib from behind forward to its anterior end, and the incision carried down to the umbilicus. The cartilaginous margin is cut through and the diaphragm incised to the hernial opening. The entire opening in the diaphragm is then sewed up and the wound closed. Auvray terms this procedure a thoracolaparo-chondro-phrenotomy.

Invasion of one side of the thorax in liberal fashion has become a more common operation since the war, and it is fair to assume that the tendency toward hesitation at the thought of thoracotomy will disappear as operations on the thorax increase.

In a monogram on surgery of the chest from battle wounds, Sir Berkeley Moynihan<sup>12</sup> makes the following comment: "The subject of thoracic surgery is one which before the war had been made difficult by the cumbersome

methods employed. The fear of pneumothorax was present in the minds of most surgeons and was a powerful deterrent." However, Bazy, of Paris, had spoken of the safety of open operations on the chest for years before the war. Cranwell<sup>13</sup> was among the first to suture the diaphragm successfully by a transthoracic approach. We have evidence that American surgeons were of the same opinion. Binnie,<sup>14</sup> in the second edition of his volume on Surgery, advocated the transthoracic operation in 1906. Carson<sup>15</sup> adopted this method of approach in 1912. Two cases of the delayed incarcerated type were operated upon by Stuart McGuire, of Richmond, Va., in 1912.<sup>16</sup> In a personal communication from Doctor McGuire I have learned of a third case which he has cured by the transthoracic operation.

In order to accomplish the desired end, Frank<sup>17</sup> found it necessary to abandon the attempt by laparotomy and at a second operation successfully closed the aperture in the diaphragm through an opening in the chest wall. Greig, of Edinburg,<sup>18</sup> has recorded an unsuccessful attempt by the abdominal approach to withdraw the herniated stomach from the thorax on account of adhesions. Downes operated upon a child of seven years by abdominal section. In addition to pyloric stenosis he found the congenital type of hernia. He met with such difficulties that he deemed it unwise to attempt reduction and suture of the diaphragm. Gastroenterostomy was done and a good functional result accomplished. Major C. D. Granger, of the British Army,<sup>19</sup> met with extreme difficulty in suturing the aperture in the diaphragm through an abdominal incision. He was unable to complete the operation satisfactorily after two hours' work on account of the collapsed condition of the patient. A case has been reported by W. J. S. Bythell<sup>20</sup> in which an unsuccessful attempt was made by Mr. Howson Ray to deal with the herniated stomach through an abdominal incision in a child of nine years. At the first operation he merely sutured the stomach to the abdominal wall. Apparently an attempt to close the gap in the diaphragm appeared to be inadvisable. The hernia soon recurred, and after a few weeks a gastrostomy was performed. Andrews<sup>21</sup> describes an operation during which he found dense adhesions of the omentum within the thorax. He was unable to separate these from below without considerable risk, so he sectioned the omentum and left it in the pleural cavity. Wiart,<sup>22</sup> in working from below, found it impossible to close the opening in the diaphragm completely. Weiss and Dujarier<sup>23</sup> found the abdominal approach so difficult that they were at the point of abandoning the operation.

A case reported by Jopson,<sup>24</sup> seen in consultation at Base Hospital, No. 18, A. E. F., was dealt with successfully by thoracotomy after a second attempt by laparotomy had failed to relieve attacks of intestinal obstruction.

Thus in scanning the literature one finds ample evidence to show that in a good proportion of cases the abdominal approach is by no means ideal and probably is beset with more difficulties and dangers than the transthoracic way.

Among the advantages which may be claimed for the thoracic operation are the following: (1) Thoracotomy affords a more direct approach. (2)



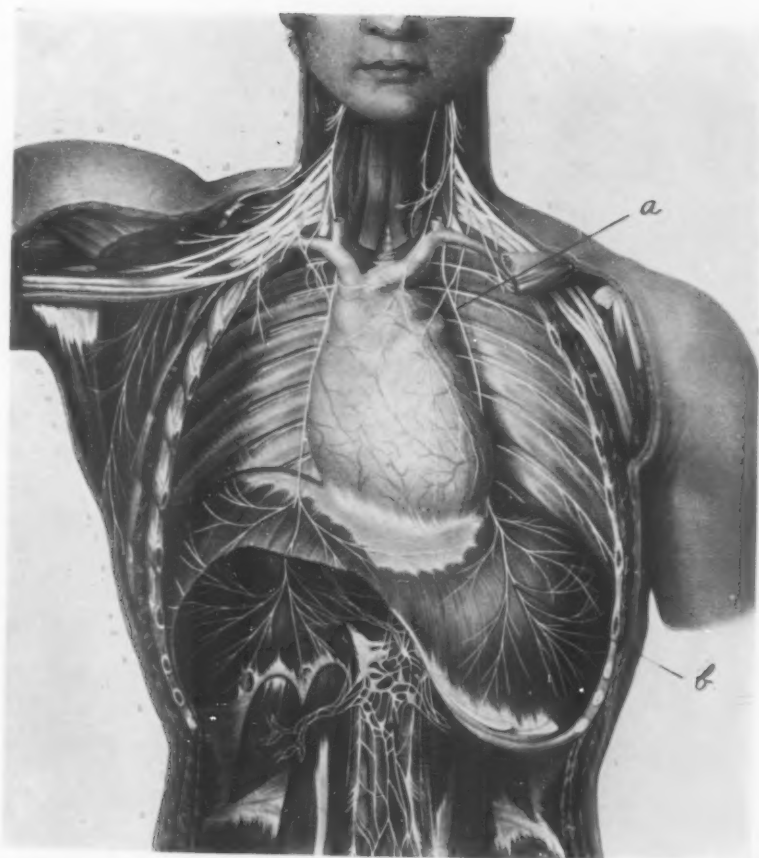


FIG. 1.—Showing (a) the course of the phrenic nerve, and (b) its distribution where great damage may result to the innervation of the diaphragm from rupture.



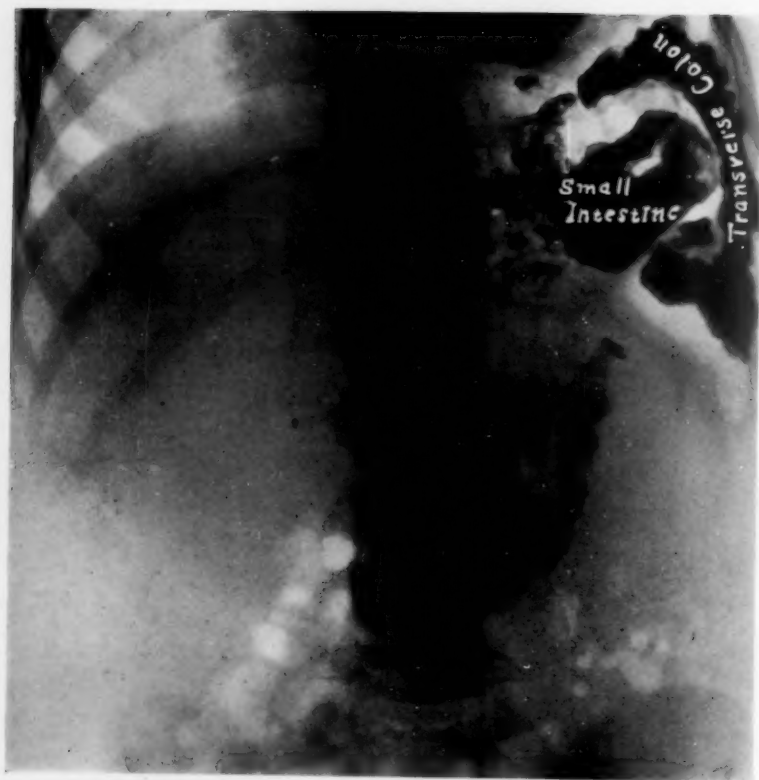


FIG. 2.—Röntgenogram showing herniated abdominal viscera in the left pleural cavity.

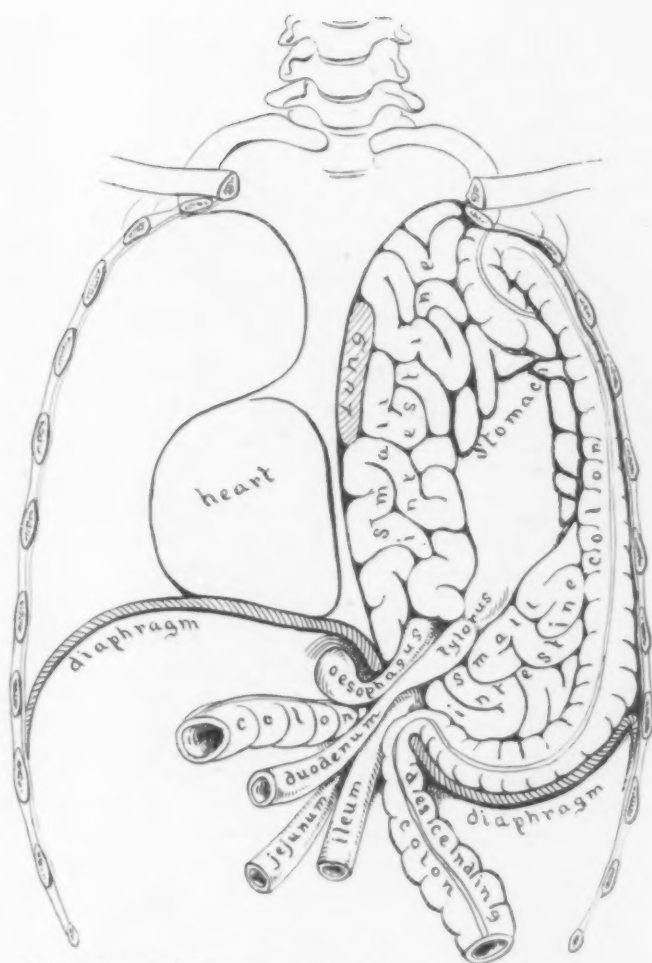


FIG. 3.--Diagram showing transposition of abdominal organs into left pleural cavity in Case I.

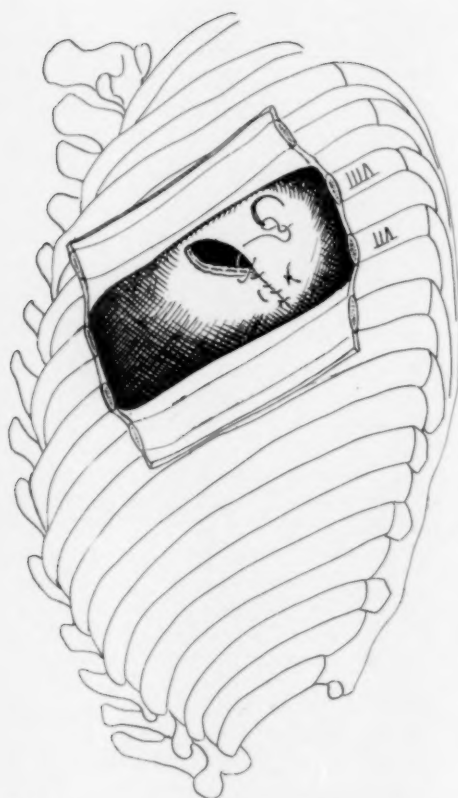


FIG. 4.—Trap-door opening in thoracic wall and suture of aperture in the diaphragm.

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Pneumothorax and collapse of the lung are not to be feared. They exist already, as inevitable consequence of a hole in the diaphragm. (3) The open thorax allows the separation of adhesions under the eye of the operator. (4) Once the herniated viscera are replaced within the abdomen, they are out of the way, warm and well protected. (5) There is less shock from the thoracic operation. (6) If a hernia sac exists it can be disposed of in the most advantageous manner. (7) Operating on the convexity is more natural and more simple than suturing within the concavity of the diaphragmatic dome.

Based on these premises the transthoracic approach to the diaphragm appears to be the more logical and sound. However, a single experience or observation is sometimes all that is necessary to demonstrate how easily one may be led to miscalculate on the virtues of a chosen method. In order to make this evident by demonstration I shall record two cases of diaphragmatic hernia in young children. Each was produced in the same manner; *i.e.*, by the passage of an automobile wheel over the upper abdomen. The two cases were comparable in their important features with a single but important exception. One was operated upon by the transthoracic approach, the other by laparotomy.

CASE I.—L. S., a boy, aged five years, was run over by an automobile on May 11, 1920. He was taken to a hospital, where examination showed that he was severely injured internally, but the exact nature of the trauma could not be determined. In December, 1920, he began to have attacks of a peculiar nature resembling intestinal obstruction. These increased in frequency and severity. On January 4, 1921, after passing through the hands of many doctors, he was examined by Dr. Henry I. Bowditch and Dr. John T. Bottomley, of Boston, who made the diagnosis of diaphragmatic hernia. Later this was confirmed by röntgenologic examination by Dr. Ariel George.

The boy was admitted to our clinic for operation on February 23, 1921. With all the evidence required in our possession, it was obvious that surgical intervention was urgent. After due consideration of the abdominal and thoracic methods of approach, it was decided to attempt a reduction of the displaced organs and a repair of the opening in the diaphragm by the thoracic route.

*Anæsthesia.*—Although the child showed no evidence of organic disease, he was anæmic and obviously asthenic. This lowered state of his endurance and the stress of the proposed operation gave accent to the importance of the choice of anæsthetic and the manner of its administration.

The anæsthetist, Miss A. M. Hunt, employed the method advocated by Sir Berkeley Moynihan, omitting his preliminary hypodermic injection of morphia, scopolamin and atropin. Nitrous oxide gas was employed for induction, shifting promptly to ether and oxygen. From the beginning the anæsthesia was pushed to a considerable depth allowing complete muscular relaxation. This was accomplished without cyanosis. From the inhalation of an excess of oxygen, a bright red color of the child was maintained. The closed inhaler of Connell was used, thus reducing the required amount of ether for the operation to about an ounce. The range of respiration was kept shallow. This partial control of motion in the thorax greatly facilitated reduction and suture.

*Operation.*—A lapel incision (Cranwell) was made through the soft tissues over the seventh and eighth ribs. The pleural cavity was opened by an inter-

costal incision the entire length of the shaft of the rib. The seventh and eighth ribs were each severed in two places, first at the angle and then at the sternal extremity. Turning the seventh rib upward and the eighth downward gave a double trap-door opening into the left thoracic cage. As soon as the pleura was incised, distended loops of small bowel escaped and could be reduced only after the intrathoracic pressure was minimized by spreading the wound wide open with rib retractors. The chest cavity was filled with stomach, small and large bowel. The left lung was collapsed against the spine and resembled the spleen in appearance. The diaphragm was prolapsed. Near its central attachments was an opening occupied by the herniated abdominal viscera. There was a close grip by the aperture upon its contents, and engorgement of the circulation indicated that strangulation was impending as a result of the stricture. There were no adhesions and no sac. Efforts to replace the intestine within the abdomen manually were encompassed with difficulties. As fast as the bowel was passed downward through the opening it was sucked up again. Repeated efforts resulted in failure and no progress whatever was made until the diaphragm was elevated to a much higher plane by placing two fingers under the outer margin of the hernial ring. Thus a partial vacuum was created within the abdominal cavity and the small gut, the transverse colon, and finally the stomach were pushed through into the abdomen by the use of long, curved, blunt forceps. Once restored, it was not difficult to keep the abdominal viscera under the diaphragm by the use of a gauze pad. The remainder of the operation was comparatively simple. Exposure of the aperture in the diaphragm was ideal. The gap began a few centimetres posteriorly and external to the œsophageal opening and extended in an oblique direction forward and outward. A moment's inspection showed that it did not involve any of the normal openings. It was somewhat elliptical with the long diameter about four inches. The edges of the opening were rounded and thickened. Closure was accomplished by a continuous suture of No. 2 iodized catgut reinforced by several interrupted deep sutures of the same material. The thoracotomy wound was closed tight with catgut and several mass sutures of silkworm gut. The little patient stood the operation remarkably well and made an uneventful recovery, leaving the hospital on the fourteenth day.

CASE II.—Was seen at the Rhode Island Hospital on the service of Dr. J. C. O'Connell, May 21, 1921. The patient was a boy, aged three and a half years. He was run over by an automobile April 28, 1921. Admitted to the Rhode Island Hospital in a state of shock. The chest signs were very unusual. Hernia of the diaphragm was suspected by Dr. R. G. Bugbee. A barium enema was administered and a röntgenogram showed the colon in the left thoracic cavity. There was a small hernia of the abdominal wall under the left costal angle produced by the weight of the wheel in passing over the child's body. Doctor O'Connell decided to approach the diaphragm by laparotomy and made his incision over the site of the hernia. Upon investigation he found that the stomach, jejunum, transverse colon and left lobe of the liver had passed through a large opening in the middle of the diaphragm. Another laceration extended transversely across the anterior third, involving the right wing of the diaphragm and opening the pericardium for a distance of about 5 cm. The heart could be seen plainly and at times dipped through the opening into the abdominal cavity. Both lacerations were closed by interrupted catgut sutures. Doctor O'Connell reports that the boy has made a good recovery and the operation a success, as shown in subsequent röntgenograms.

The surprise in this case was the laceration extending across the diaphragm to the right side and laying open the pericardium. It might not have been overlooked during an approach from above, but there is a fair if not a

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big liability, that it would have passed unseen. This case accentuates the importance when operating through the chest wall of palpating the underside of the diaphragm as far as the hand can reach.

Aside from the advisability of using the abdominal approach whenever it is thought necessary to operate on a hollow viscus, it must be conceded that another strong argument, if not an incontestible one in favor of laparotomy, is the opportunity thus afforded for examination of the entire diaphragm.

Operation for the cure or relief of diaphragmatic hernia during childhood is rarely found in literature. Many text-books on Pediatrics fail to mention the subject. Holt describes a case of diaphragmatic hernia observed in a child sixteen months old who died of pneumonia at three and a half years. In concluding his notes the author states that the condition is not amenable to treatment. The case recorded by Downes and that reported by Bythell have been noted already. They were of congenital origin.

That the traumatic cases should be operated upon as soon as conditions warrant there can be no question. One should be able to make the diagnosis promptly if the physical signs are carefully noted with diaphragmatic hernia taken into consideration. Nevertheless, immediate operation is inadvisable because a state of shock exists as a result of lung collapse and pneumothorax, not hemorrhage. The amount of bleeding from the torn edges of the diaphragm is probably slight.

A case reported by Balfour, although an adult, was of the non-strangulated type of hernia of the diaphragm in which the diagnosis was made prior to operation. In many respects the conditions were analogous to those found in the cases recorded in this paper. Balfour's difficulties were encountered essentially after reduction of the herniated structures. He found no difficulty in withdrawing the abdominal viscera from their position in the thoracic cage, but it was a struggle to prevent them from being sucked back. This was accomplished by introducing large retaining packs of gauze held in a position for retention by outspread hands. So it was in Case II, O'Connell was continually annoyed by the escape of the abdominal viscera from behind the retaining packs. Our embarrassments occurred earlier and consisted of an almost insuperable task met in passing the herniated stomach and intestine through the aperture in the diaphragm into the abdominal cavity until a vacuum was created within the abdomen as already described. Catgut was used in both of these cases for closure of the apertures. In one the continuous suture was used, and in the other the interrupted stitch was employed. With the interrupted suture small open gaps remain, while the continuous stitch makes a tight line. With several interrupted supporting sutures this airtight closure is to be preferred.

### CONCLUSIONS

1. Early recognition of diaphragmatic hernia has reduced the surgical mortality from 75 per cent. to 10 per cent.



2. An important type resulting from external violence is now recognized among pedestrian children.

3. Many congenital hernias of the diaphragm do not require operation.

4. The thoracic operation affords a direct approach; also many advantages in dealing with intrathoracic adhesions and actual repair of the aperture in the diaphragm.

5. The abdominal approach allows inspection and repair of a gap in either side of the diaphragm. Its simplicity is enhanced by a low diaphragm and the absence of adhesions within the thorax.

6. The combined operation is a third choice, preferable only to separate incisions, thoracic and abdominal.

7. The choice of operation must remain the individual surgeon's problem, to be decided upon a consideration of all the factors in each case.

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- <sup>24</sup> Trans. of Amer. Surg. Asso., 1920, vol. xxxviii, p. 624.

## PERNICIOUS ANÆMIA WITH SPECIAL REFERENCE TO THE SPLEEN AND THE LARGE INTESTINE\*

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PERNICIOUS anæmia is characterized by progressive degeneration of the red blood, permanent change in the method of the production of blood, marked changes in the spinal cord, achlorhydria, and glossitis. The relation of the cord changes, achlorhydria, and glossitis to the anæmia has not been determined. The view held formerly, that the conditions were dependent on the anæmia, is scarcely borne out by the fact that the symptoms are found in the earlier stages of the disease, neurologic examination showing that the cord changes may be as characteristic at any stage of the disease as the blood picture. The etiology of pernicious anæmia is unknown, the early symptoms are indefinite, and by the time a diagnosis can be established the condition is incurable.

It has been asserted that certain cells found in the blood of patients with pernicious anæmia are characteristic, but most observers agree that the pathologic change is in the blood as a whole, rather than in the development of specific types of blood-cells. While it is known that the actual perversion of the red-cell formation lies in the bone marrow, few believe that the cause originates therein. One might say that the bone marrow of a patient who has died from pernicious anæmia furnishes only presumptive evidence of the disease. The pathologist would indeed be enthusiastic who asserted that in anæmia other than of the aplastic type he could make a diagnosis of pernicious anæmia from the bone marrow examination alone. The diagnosis of pernicious anæmia is by no means certain in the early stages. Most diagnosticians have had under their care patients believed to have pernicious anæmia in the early stages who recovered with or without treatment. All have seen patients in whom the disease was so insidious in its manifestations that it had reached the incurable stage before its existence was suspected. Giffin, Woltman, and Szlapka now have under observation a number of cases in which there are achlorhydria and some evidences of changes in the cord and tongue, but as yet without anæmia. It will be interesting to learn in what percentage, if any, of these cases pernicious anæmia develops.

### THE RELATION OF THE SPLEEN TO PERNICIOUS ANÆMIA

The relation of the spleen to the formation of the blood led the earliest observers of pernicious anæmia to suspect that the spleen was associated with the disease. It remained for Eppinger to suggest that the removal of the spleen might cure, and early reports give testimony of temporary relief after splenectomy sufficient to justify a fair trial of the operation. Considering the confusion which so often attends the early diagnosis, it seems probable

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that obscure cases of hæmolytic icterus and splenic anæmia may have been accidentally included in the pernicious anæmia group, especially since the pathologic changes in the spleen in pernicious anæmia are not characteristic of the disease. Removal of the spleen in such cases has possibly given the impression that splenectomy may cure pernicious anæmia. It has been a tradition of the medical profession that recovery of a patient in the face of a diagnosis of pernicious anæmia proves the diagnosis wrong, and this conviction is still so strong as to prevent our readily accepting reports of cures. Even a superficial examination of the literature on pernicious anæmia brings out in striking manner the fact that any form of treatment for pernicious anæmia may be beneficial, or at least may appear to be beneficial. Patients with pernicious anæmia have their ups and downs, and in an occasional case in which the diagnosis seemed to have been established by physicians of repute, there has been recovery which has lasted for years. Eppinger's work at least demonstrated that the removal of the spleen initiated striking temporary improvement. In the cases observed in the Clinic there was marked gain in weight, and improvement in hæmoglobin on an average of from thirty-six to seventy-two per cent., and the red-cell count increased on the average from less than 2,000,000 to more than 4,000,000.

Previous to November 1, 1917, fifty splenectomies had been performed in the Clinic for definitely established pernicious anæmia. The operation was then discontinued almost entirely for three and one-half years. Since there was not sufficient evidence that splenectomy would cure these patients, and since at that time the procedure was not known to give a degree of palliation sufficiently greater than that following blood transfusion, it seemed wise to await the verdict of time. Giffin and Szlapka have recently investigated the condition of these fifty splenectomized patients, and the pessimism which existed in the Clinic has been partly dispelled, at least. It was found that twenty-one and three-tenths per cent. of the patients with pernicious anæmia survived the operation three years or more, living two and one-half times as long as the average in a similar group of nonsplenectomized patients at the same stage of the disease, and that ten and six-tenths per cent. are alive after more than five years. This clearly indicates in at least one-third of the cases that the average life of patients with pernicious anæmia is greatly prolonged, and in about ten per cent. the prolongation is sufficient to lead to the hope that cures may result in some cases. We must take into consideration too the fact that no allowance was made for the normal mortality for the age period; all the patients who died were considered to have died from pernicious anæmia. In the literature I have not found a comparable group of non-splenectomized pernicious anæmia patients who have done as well. The results in these fifty patients have been much better than we expected they would be when we abandoned the operation; they suggest that in certain early cases, of a type as yet not fully recognized, splenectomy offers a possibility of cure. Not only is this true, but also in the average cases the palliation following splenectomy is much greater than we have been able to obtain

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by blood transfusion. Transfusion gives temporary benefit. It seems to furnish red cells which may live and function for one or two months or more, but there is not as yet evidence that the actual prolongation of life by that means is considerable. The blood picture improves after splenectomy, but the achlorhydria continues, and careful examination of the nervous system does not show changes for the better in the physical condition of the nerve structure, although the patients are much better in this respect clinically. A perhaps comparable showing was made by Stokes, in the Clinic, who found that careful treatment in syphilis of the nervous system made eighty-six per cent. of the patients self supporting, although the neurologists on examination were not able to find that there had been any marked change in the physical condition of the nervous system. Perhaps a lesion in the spinal cord gives physically the same signs whether the process is active or whether it is the scar of a former lesion. Clinically an ulcerating syphilitic lesion of the skin is more troublesome than the scar of a healed lesion.

The course of pernicious anæmia following splenectomy, generally speaking, is ameliorated, the relapses are less severe and the cord changes less rapid than after transfusion or any other form of treatment with which we are acquainted. One of the functions of the spleen is to destroy deteriorated red cells. Apparently in pernicious anæmia the red cells are born feeble and the spleen sacrifices red cells which, although imperfect, are the best the patient can produce and are capable of function. Removal of the spleen stops this destruction, but does not greatly affect the disease otherwise. The cases which seem to be most favorable are those in which hæmolysis is most active, and those least characteristic of the disease. It also seems certain that early cases give a better prospect of benefit than late cases. When the disease has advanced to the point at which the bone marrow has been injured beyond the power of recuperation, the most to be expected is a temporary abatement of the symptoms.

Pathologic examination of the spleens we have removed has been rather disappointing. If we might assert that in the cases of pernicious anæmia in which splenectomy was performed characteristic pathologic changes are found in the spleen, or that greater clinical improvement followed splenectomy in pernicious anæmia when the spleen was greatly enlarged, we could establish a definite relationship between the enlarged spleen and the disease, but the size of the spleen did not seem to bear any definite relationship to the severity of the disease. Necropsies after death from pernicious anæmia have often shown the spleen to be small, but during the life of the patient the spleen is usually enlarged. The average weight of the spleens removed in our cases was 400 gm. (195 gm. normal, Sappey) exclusive of two large spleens, one of which weighed 1600 gm., and the other 2220 gm. It seems probable, therefore, that during the course of pernicious anæmia the spleen is enlarged, but that this enlargement is reduced to a certain extent in the terminal stages of the disease. The spleens removed during the earlier stages of the disease, therefore, would show an average greater weight and size than would be found at ne-

cropsy. In only two of our cases (both terminal) was the spleen below normal size. In pernicious anæmia of the aplastic type the changes in the bone marrow are most marked and the spleen small. Whether this has any significance I do not know.

The question is not yet answered whether pernicious anæmia is a definite entity or whether it is a terminal change of several conditions, and recognizable as pernicious anæmia only when the patient has reached the state which we know will eventuate in death. If we assume that the removal of the spleen has a beneficial effect, as appears from the evidence at hand, are we to assume also that the spleen is the cause of the changes in the bone marrow? A study of the literature and of our cases does not give this impression. It would be more reasonable to assume that the same agents which destroy the bone marrow injure the spinal cord, produce the achlorhydria and the glossitis, affect the spleen, and that by removal of the spleen a vicious circle is interrupted.

The operation of splenectomy for pernicious anæmia is simple. Among the first nineteen patients we had three deaths. The patients were operated on during crises as a last resort in very advanced cases. The best plan is to transfuse once or twice in order to get the patient on the up grade before operating and not to operate during a crisis. We have had no operative death in the last forty cases.

#### THE POSSIBLE RELATION OF THE LARGE INTESTINE TO PERNICIOUS ANÆMIA

Many observers have expressed the belief that toxic materials from the gastro-intestinal canal are the cause of pernicious anæmia, and if this is true the probable location of this absorption would be in the proximal half of the large intestine. In a former communication\* I discussed the physiology and pathology of the right half of the large intestine, my interest being excited primarily by the frequency of surgical tuberculosis and carcinoma of the large intestine, and still further by the work of Lane on intestinal stasis, which, like Banquo's ghost, will not down. There is a mystery concerning this portion of the human anatomy which conceals some queer metabolic disturbances, possibly, as I pointed out before, the result of throwing protein end products, which quickly undergo putrefactive changes, into an organ like the proximal absorbing half of the colon which primarily has an herbivorous function. Carcinoma or tuberculosis of the proximal half of the large intestine produces an anæmia, unexplained by hemorrhage, much more severe than the anæmia of carcinoma or tuberculosis of any other part of the body. Carcinoma of the fundus of the stomach perhaps is the only condition which produces an unexplained anæmia which is in any way comparable. Tumors in the right half of the colon which are curable by operation may cause a reduction of the hæmoglobin to below twenty-five per cent, edema of the lower extremities and a general physical condition which would apparently place the patient beyond surgical interference. Experience with a large number of re-

\* Mayo, W. J.: Resection of the first portion of the large intestine and the resulting effect on its function. Jour. Am. Med. Assn., 1914, lxiii, 446-449.



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sections for the relief of such patients in wretched general condition has shown a comparatively low mortality and a high percentage of permanent cures.

The flaw in Lane's assumption that the colon is the source of toxins is the failure to find evidence of disease on removal of the colon, beyond adhesions, dilatation and atony. Yet the same is true of exophthalmic goiter; the thyroid tissue of the hyperthyroidism is, strictly speaking, not so much abnormal as hypertrophied and superactive.

Some very interesting observations on *Balantidium coli* as the cause of blood and cord changes of the pernicious anæmia type have been made by Logan, of the Clinic, and, in a way, the cases studied support the hypothesis of the intestinal origin of pernicious anæmia. The *Balantidium coli* is a flagellate parasite which rarely inhabits the intestinal tract of man, but is common in the pig. In man it is found in the intestinal wall, the blood-vessels, and other organs; it has the power of encysting and produces ulcers. The symptoms and findings of pernicious anæmia or of an anæmia which cannot be distinguished from it accompany the chronic type of the infection. Eosinophilia is not present in the chronic cases. Glaesseeur has found a hæmolytic agent in *Balantidium coli*. Since this parasite penetrates the intestinal wall and its blood-vessels and other organs of the body, and encysts, it is impossible to be sure that the organism is not harbored in the tissues of the body simply because it has been eradicated so that it is no longer found in the stools. Thus, if the pernicious anæmia syndrome persists, it cannot be determined whether the *Balantidium coli* hæmolyisin is still active, or whether once the complex is started it becomes an entity. In any event the pernicious anæmia of *Balantidium coli* progresses to a fatal issue. The number of observed cases is small and the pernicious anæmia might have been a coincidence. Honest card players have been known to hold four aces.

I fully realize that there is little evidence to show that the etiologic agents of pernicious anæmia arise in the large intestines. Pernicious anæmia annually destroys more than 6000 lives in the United States. Even though the disease is common, we have learned comparatively little concerning it during the past generation. It behooves us to keep an open mind, to study carefully the blood conditions of all patients who have disease of the large intestine, to try to ascertain whether anæmia, achlorhydria, glossitis, or some other abnormal condition exists, and especially to study carefully all cases in relation to cause and effect in which the large intestine is removed or in which splenectomy is performed.



## SOME SECONDARY COMPLICATIONS OF POSTERIOR GASTRO-ENTEROSTOMY\*

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SINCE during the last few years the end results of surgery are being studied more and more and the value of an operation is based upon the eventual benefit which the patient has derived, I believe that the following two cases of posterior gastro-enterostomy, with their secondary complications and their end results, are of sufficient interest to bear reporting.

CASE I.—J. E. T., Raquette Lake, N. Y., age forty-nine, United States guide and gardener, entered the Albany Hospital August 5, 1910. Discharged September 2, 1910. Recovered.

Patient states that about seven years ago he had attacks of stomach trouble and was treated by his physician for indigestion. He has had a number of these attacks ever since, averaging about four each year. On July 6, 1910, while at work, he was taken with dull pain in epigastrium extending down to umbilicus; at times the pain would radiate downwards towards pubes and also around to back on both sides, but being more persistent on right side. He stopped work on July 8th, and went to bed July 13th, on the advice of his physician. Has been out of bed since July 18th. On July 6th he had an attack of nausea and vomiting. On July 27th he had another attack of nausea and vomiting. He says that his appetite is good but a little food seems to satisfy him. He has never seen any blood in vomitus nor does he recognize any particles of food of previous meals. There is no certain time after meals for vomiting to recur; says it may vary from four to six hours or more. Patient can eat fruits, tomatoes, but meats seem to distress him. At times he has eructations of acidulous fluid into mouth. Tongue is slightly eroded in middle but red on edges and tip.

Physical examination revealed a small indurated mass in the epigastric region, rather to the right of the median line. No glands palpable in the body. Examination of stomach contents disclosed a small amount of blood, undigested food and lactic acid bacilli. Examination of urine showed a large number of hyaline and granular casts, about 3 per cent. of albumin, no sugar, specific gravity 1016.

It being before the time that the technic of the X-ray examination of the intestinal tract had been developed, no radiographic examination of stomach was made. From the clinical history and the physical findings a diagnosis of pyloric obstruction was made, probably malignant in character.

Operation, August 10, 1910. A tumor size of a horse chestnut, having many characteristics of an inflammatory nature, was found at

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\* Read before the American Surgical Association, June 16, 1921.

## COMPLICATIONS OF POSTERIOR GASTRO-ENTEROSTOMY

the pyloric end of stomach, causing partial obstruction. No lymph-glands found involved. A posterior gastroenterostomy was made. An uneventful convalescence followed, and the patient left hospital on September 2nd apparently well and eating anything he wished. Pathological report of intestinal mucosa was negative. No evidence of malignancy in fragment submitted. Examination of urine upon discharge from the hospital was practically negative. This man reentered the hospital October 11, 1913, for removal of a prepatella bursa of right knee. He reported that he had no trouble from his stomach whatsoever and could eat any kind of food without distress.

He again entered the hospital October 21, 1914, complaining of pain and distress in his stomach, and frequent urination. Examination of specimen of urine at that time gave results as follows: No sugar, granular and hyaline casts, acid 1018, albumin. Smears—no tubercle bacilli or other organisms seen. Cultures—sterile at the end of forty-eight hours' incubation.

The patient admitted having partaken freely of alcoholic stimulants for the past few months.

Under appropriate treatment stomach and kidney condition cleared up and he left the hospital October 27, 1914, recovered.

He reentered the hospital October 8, 1918, complaining of distress and pain in stomach and diarrhoea. At this time Röntgen diagnosis was: Oesophagus normal. In standing position the stomach empties very rapidly through the gastro-enterostomy opening, but some barium is seen to leave by the pylorus. No incisura, filling clefts or notches seen. Cap seems normal. The stomach does not empty so fast through gastro-enterostomy opening in prone position. There is very slight six-hour retention. Barium has reached the descending colon, but most of it is in the cæcum; a small amount is in the small intestine.

Owing to the clinical and X-ray findings, an exploratory operation advised. Patient returned home and returned at the end of a week, and entered the Homœopathic Hospital, where the abdomen was reopened through the old scar. Examination of the pylorus, the site of the tumor found at the operation August, 1910, revealed a normal pylorus with absolutely no evidence of any tumor or cicatricial tissue. At the site of the gastroenterostomy, however, was found a tumor mass about the size of the one previously found at the pylorus. In addition the lymph-glands along the spine were involved. Clinically, the case presented was one of carcinoma. Owing to the poor condition of the patient no tissue for pathological examination could be removed. The incision closed. The patient is still living, two and a half years afterwards. Why did this man not make a complete cure?

There is much doubt as to the case being malignant, but is it not quite probable that it is one of those cases which we are beginning to recognize as a secondary ulcer occurring at the site of the gastro-enterostomy? Where is the fault in this case along the line of metabolism producing a condition tending to gastric ulcer? This case presents two interesting points. First, the fact that in cases of inflammatory or malignant disease where we can

stop the irritation of the growth, we can either stop the growth and have it disappear entirely as it did in this case, or else we can so diminish its growth as to greatly relieve the patient, as is shown in cases of carcinoma of the rectum relieved by a colostomy and the patient given comfort for months, if not years.

The second point is the appearance of the growth, possibly carcinoma, at the site of the anastomosis, showing that the irritation of the gastric juice must have set up a new growth entirely independent of the previous growth at the pylorus. Case is now in the hands of Doctor Worrell, who diagnosed the case as one of chronic interstitial nephritis.

CASE II.—G. Y. H., Jr., aged thirty-six, single, farmer by occupation, was brought to hospital on January 11, 1915, in a state of collapse, and with the history that for past two or three years he had had trouble with his stomach. In the beginning there was only pain in the stomach before meals, which pain was relieved by eating. About three hours after eating the pain would return. He would have a lot of gas on stomach. Later pain diminished somewhat and patient would vomit large quantities of food. This vomitus would be of a sour taste, burning when it came up and of a dark brown color. During the night of January 11, 1915, he was seized with severe pain in the epigastric region, and went into a state of collapse. He was operated upon next morning for a perforated gastric ulcer. Closed by use of silk purse-string suture. Drainage with gauze and one rubber tube. Counter-drainage in right iliac fossa. He left the hospital February 4, 1915, apparently well.

He reentered hospital March 25, 1915, complaining of pain in region of old trouble. Since leaving the hospital in February has some pain, but is bothered with distress in stomach and would vomit occasionally, the vomitus being light in color. He entered hospital March 25, 1915, to be relieved of distended stomach. Posterior gastroenterostomy performed March 26, 1915, from which he made a good convalescence and left the hospital April 14, 1915, feeling absolutely well and able to eat anything in reason.

He remained well for two years, when he commenced to complain of his old symptoms, which would yield at times to appropriate treatment. On February 23, 1919, he was seized with an acute pain in the epigastric region and went into a state of collapse, from which he rallied and the pain gradually localized itself in the region of the appendix. He was brought to the hospital; an incision was made over the region of the appendix, which was removed, slightly congested, but the abdomen was found full of gastric contents. An incision was then made through the old gastroenterostomy wound and a perforated ulcer found at the site of the anastomosis on the jejunal side. This perforation was closed by a mattress silk suture. Two rubber drainage tubes inserted in upper and lower edges of wound. He made a slow but uninterrupted convalescence and left the hospital March 6, 1919, in good condition. He has remained well ever since, has had no more distress in stomach, is able to eat anything he wishes, and has gained considerably in weight.

## COMPLICATIONS OF POSTERIOR GASTRO-ENTEROSTOMY

The interesting point in this case is the fact of his developing an ulcer at the site of the anastomosis giving very little, if any, symptoms, until its final perforation. Also the fact that he made a good recovery from the perforation even though the diagnosis and operation were delayed for twenty-four hours. I am free to confess that I should have made the diagnosis more promptly, but the fact that he had had very slight previous gastric symptoms and that he had had one perforated gastric ulcer did not seem to make it possible that he should have another. As a matter of fact, the possibility of such a condition being present was not even thought of.

That peptic ulcer occurs at the site of a gastroenterostomy is of course a well-known fact, and numerous cases of that condition are reported in the literature. Various theories are advanced for the same, and the fact that they do occur probably accounts in part for some of the failures to give relief in stomach surgery.

A thorough search of the literature, however, fails to reveal the report of a case of perforation of an ulcer so occurring. Though, of course, there is no reason why a perforation could not occur as well in that situation as in a primary gastric or duodenal ulcer. So far as treatment is concerned, I merely closed the perforation by a purse-string silk suture and drained. He has had no subsequent symptoms.

Contrast these two cases with the history of a third patient, Mr. G., aged sixty-six, upon whom I operated for a stenosis of the pylorus, performing the identical form of operation, who had absolutely no stomach symptoms afterwards, lived for fifteen years and then died of pneumonia.

Why should the two cases in the younger patients develop secondary ulcer and the third case, in a much older man, make practically a perfect recovery?

## TYPICAL FIBROMYOMA OF THE ABDOMINAL WALL FOLLOWING HYSTERECTOMY

BY GEORGE EMERSON BREWER, M.D.

OF NEW YORK

THE object of this communication is to report and place on record the history of a patient in which a large, typical, fibromyomatous tumor developed in the abdominal wall, in the scar of a previous laparotomy undertaken for the removal of an uterus, which was the seat of multiple growths of the same character.

In May, 1911, Mrs. E., thirty-one years of age, sought my advice in regard to treatment of a large tumor of the lower abdomen, which upon investigation proved to be a uterine fibroid. As the tumor had been growing rapidly and had already given rise to definite pressure symptoms, an operation for its removal was suggested. Accordingly under ether anæsthesia, after the usual preparation, the abdomen was opened in the median line and the uterus, both tubes, and the left ovary were removed. On subsequent examination, the uterus was found to be the seat of several fibromyomata, varying considerably in size, the largest arising from the posterior wall near the fundus, measuring about 50 cm. in circumference. The patient made a satisfactory convalescence, the abdominal wound healing by primary union.

She remained well for nine years. In the late autumn of 1920, however, she began to experience a sense of weight and indefinite pain in the lower abdomen and right side. These symptoms were not constant, but would recur after severe or unusual exertion; and in January, 1921, there was added a slight irritability of the bladder which gradually increased, necessitating frequent micturition. There was no noticeable interference with nutrition, no loss of strength, and no anæmia; but the symptoms gave rise to a certain degree of anxiety and apprehension, which finally led her again to seek my advice.

On physical examination, an oblong, oval tumor was found in the lower abdomen, reaching from the pubis upward and somewhat to the right to a point three inches below the umbilicus. The tumor was moderately movable, was not tender, had a smooth uniform surface, and gave to the examining hand the sensation of an ovarian cyst. On bimanual examination these findings were verified, and I was convinced that we had to do with a cyst arising from the remaining right ovary, pressing upon the bladder, and not attached to the cervical stump which was freely movable without transmitting its motion to the tumor. As there was no unfavorable factor revealed by the general physical examination which followed, an operation for the removal of this supposed ovarian cyst was advised. On January, 1921, at the Presbyterian Hospital, under ether anæsthesia, an incision was made through the right rectus muscle. As soon as the fibres of this structure were retracted, there was exposed what was thought to be a greatly thickened and highly vascular peritoneum, numerous large veins passing irregularly across the field in various directions and apparently ceasing abruptly as if they penetrated to some deeper structure. Several unsuccessful attempts were made to incise the peritoneum, but the blade of the scalpel opened no cavity, and seemed only to incise a dense solid mass which bled freely. Believing that these conditions only indicated that the cyst was densely adherent to the thickened parietal peritoneum, I divided the tissues carefully, until I exposed a

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\* Read before the American Surgical Association, June 15, 1921.



## FIBROMYOMA OF THE ABDOMINAL WALL

grayish, non-vascular, fibrous membrane, which I thought to be the cyst wall. From this I separated the thickened tissue on either side by blunt dissection, until a sufficient area was exposed to convince me that it was the surface of the tumor. An aspirating needle was then introduced, but without result, other than imparting to the hand the sensation that it passed into a dense fibrous mass.

Still convinced that I was working within the peritoneal cavity, and that I was dealing with a solid tumor arising from some one of the abdominal viscera, I attempted cautiously still further to expose its surface by separating from it its dense fibrous and vascular envelope. Much to my surprise, as I worked outward from the median line, I was able soon to detect with my finger a distinct line of cleavage, and in a few moments was able easily to enucleate the entire tumor from its bed. After its removal I found that at one point a small opening had been made through the posterior wall of the surrounding membrane into the peritoneal cavity. This opening was enlarged sufficiently to admit my hand, when it was found that the inner layer of the peritoneum was perfectly smooth and free from adhesions with any of the abdominal viscera. This conclusively demonstrated that the growth was an extraperitoneal tumor lying between the peritoneum and the rectus muscles, surrounded by a dense, highly vascular capsule made up of thickened and subperitoneal areolar tissue.

On section the tumor presented the gross appearances of a typical fibromyoma, without any suggestion of malignancy. After accurate hæmostasis, the peritoneum was united with catgut, the muscular and aponeurotic structures with chromic gut, and the skin incision closed by silkworm-gut and silk sutures. Her recovery was without incident, and except for the usual post-operative sensations, she has enjoyed the best of health.

On examination the tumor was found to have the following measurements: 16 cm. in length, 13 cm. in breadth, and 9 cm. in the opposite transverse diameter.

The appearance of the tumor and the cut surfaces may be seen in Figs. 1 and 2. The following report on the microscopic examination of the tissue was furnished by Dr. Arthur Purdy Stout, Assistant Pathologist to the hospital.

"Gross Specimen: Specimen consists of a firm tumor mass measuring 16 x 13 x 9 cm. The surface for the most part is smooth and glistening; it is somewhat nodular. Cut surface shows a dense white tissue which is made up of numerous interlacing bundles of tissue. Tumor weighed two and a quarter pounds."

"Microscopic Examination (Fig. 3): Section shows bundles and strands of what is apparently fibromuscular tissue. The spaces between these are filled with a rather homogeneous tissue containing elongated nuclei; in places the tumor is exceedingly cellular, and elsewhere there is some evidence of degeneration."

"The Van Gieson stain shows that the tumor is composed almost entirely of fibrous tissue and smooth muscle."

"The Weigert stain shows the absence of elastic fibres." Diagnosis: Fibromyoma.

From this report it will be seen that the tumor removed from the subperitoneal space in the anterior abdominal wall was a typical fibromyoma, similar in gross and microscopic appearances to the ordinary fibromyomata so commonly found in the uterus.

To account for the development of this tumor in this unusual location, in the writer's opinion, we can consider only four possibilities: First, that it arose spontaneously from the subperitoneal connective tissue; second, that it developed from the urachus; third, that it was of teratomatous origin; and fourth, that it was an implantation tumor originating from some minute frag-



ment of the primary tumor left in the abdominal incision at the time of the previous operation.

Before entering into a discussion or critical analysis of these four hypotheses, I may be permitted to state that, as a result of a fairly diligent but by no means exhaustive search of the literature of the subject, in which I have been aided by the advice of Professor W. H. Welch of Baltimore, Professor James Ewing of the Cornell Medical School, and Professors Jobling and William C. Clarke of the School of Medicine of Columbia University, as well as by a number of our best authorities on gynæcology and abdominal surgery, I have been unable to find a report of a single case of a typical fibromyoma of the abdominal wall. I have likewise been unable to discover an authentic instance of a tumor of this variety arising from areolar or fatty tissues in any part of the body; and no record has been found of a fibromyoma developing from the urachus, whether patent or obliterated.

These facts, and the recognized impossibility of leiomyomatous tumors developing from tissues containing no smooth or unstriated muscular fibres, would enable us at once to exclude the first hypothesis, that such a neoplasm could spontaneously develop in the subperitoneal areolar and fatty layer of the abdominal wall.

In regard to the urachal origin of our growth, one had to be somewhat more guarded, as the urachus is known to contain a definite layer of unstriated muscle; and even after birth these muscular fibres generally can be demonstrated in the fibrous cord representing the obliterated canal. The absence, however, of any recorded example of a fibromyoma arising from this structure, and the absence of any evidence in this case of an attachment to anything resembling the urachal cord, would render our second possibility highly improbable.

In regard to the third, or teratomatous origin of the tumor, it must be admitted that the median line of the abdomen is a well-recognized habitat for these minute islands of embryonal tissue and numerous examples of teratomatous growths from these rests have been recorded.

In all such cases, however, that have been carefully examined, although one type of tissue may preponderate and make up the great mass of the tumor, a painstaking search will always reveal the presence of other types of tissue in some part of the neoplasm. The absence in this instance of any evidence of the presence of other types of embryonal tissue would lead one logically to exclude this explanation of its origin.

In regard to the fourth hypothesis, that it arose from the implantation, in the line of incision, of a minute fragment of the uterine tumor removed ten years before, the writer is of the opinion that this is by far the most probable and reasonable explanation of its occurrence. This opinion is based upon the following facts: First, the coincidence of the development of this tumor in an individual who had previously harbored an exactly similar growth in a neighboring structure; second, that in its removal the tumor-bearing organ with its divided and exposed tissues had been for some time



FIG. 1.--Photograph of gross specimen--removed from the abdominal wall.

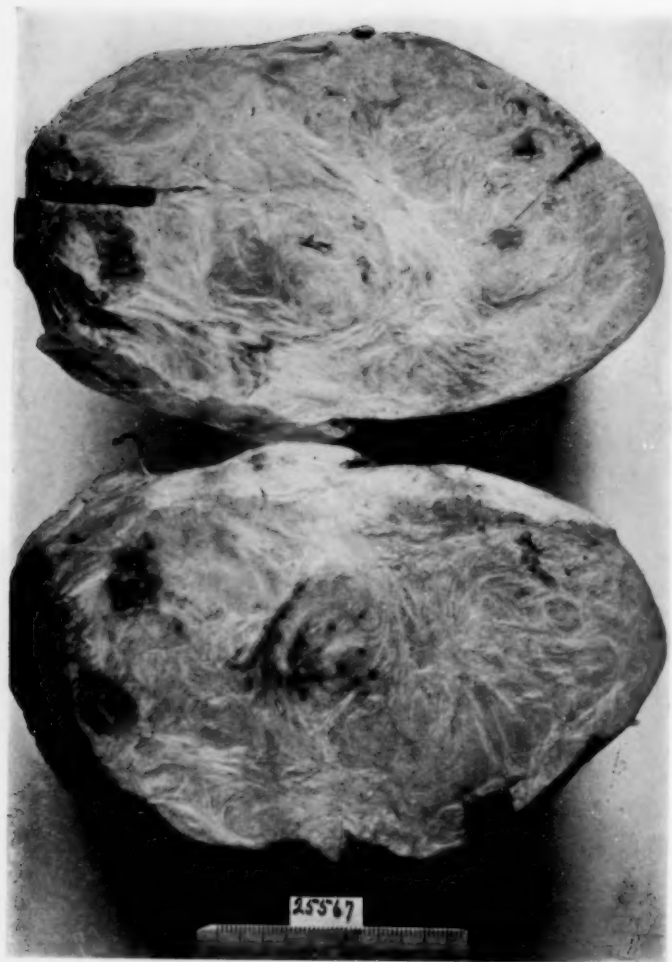


FIG. 2.—Cut surfaces of tumor.

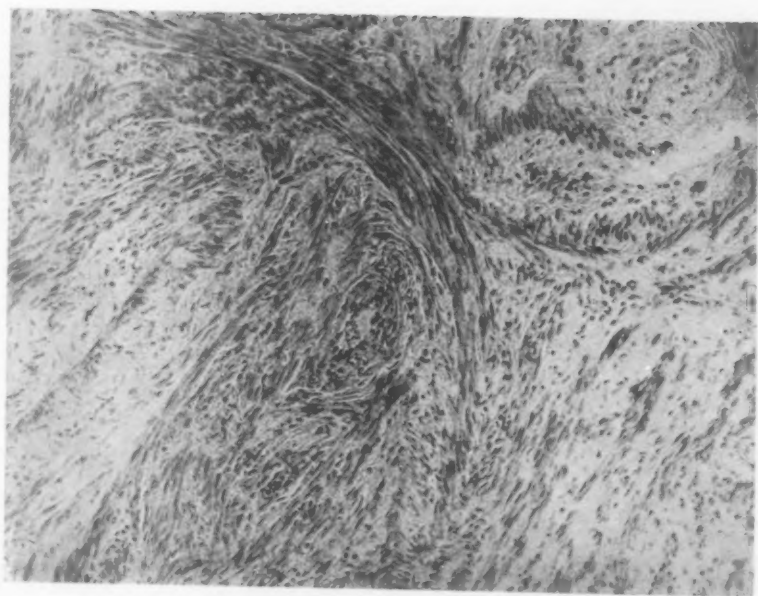


FIG. 3.--Microscopic appearance of tumor.





## FIBROMYOMA OF THE ABDOMINAL WALL

in actual physical contact with the divided and exposed tissues of the abdominal wall, in the exact location in which the secondary growth subsequently developed; third, the well-known and generally recognized fact, that certain cutaneous and mucous membrane tumors which are in close or frequent contact with neighboring tissues, not infrequently give rise to similar growths in the tissues thus exposed; fourth, that modern experimental surgery has furnished innumerable examples of successful grafts of tumor tissue as well as normal glandular structures, in both animal and man; and fifth, that surgical literature records not a few examples of both benign and malignant tumors arising in the immediate neighborhood of incisions previously made for the removal of histologically similar growths; as well as tumors developing from the accidental implantation of aberrant fragments of normal tissues or cells into a new and histologically different environment.

As examples of the first may be mentioned the not infrequent development in an abdominal scar, of a malignant growth after operation for the removal of a similar neoplasm of one of the viscera; and the occasional recurrence of ovarian cystomata or adenomyomata after similar procedures.

In a recent article by Cullen, published in *Archives of Surgery*, September, 1920, entitled "The Distribution of Adenomyomas Containing Uterine Mucosa," three such cases are reported involving the abdominal wall, one in which the uterus was ruptured during a curettement for abortion with immediate laparotomy for surgical repair of the uterine wound, and two others following operations on the uterus or adnexa.

The writer may be permitted to state that his opinion as to the implantation origin of the tumor reported in this communication was greatly strengthened by a personal letter received from Professor Welch, in which the following view was expressed:

"I find no difficulty in accepting your suggestion of the origin by implantation of the fibromyoma of the abdominal wall, and this seems to me the most probable explanation. What speaks for the implantation origin in your case is, first, the location, precisely in the scar of incision, and secondly, the obvious opportunity for implantation at the time of the previous operation. Much more complicated tumors, for example, ovarian cystomata, may thus arise by implantation in abdominal scars.

"I know of no case identical with yours, and this exceptional occurrence indicates that the conditions for a successful graft by implantation at operation on uterine myomata must be very rarely met, but myomata may develop from cells transplanted from an original tumor, and there is no inherent improbability in my opinion in assuming the similar origin by implantation in your case. I see no reason to think of a possible teratomatous origin."

Although the writer from his limited search of the literature would not presume to claim that the finding of this tumor in this unusual locality was a unique occurrence, still, from the evidence reported, the condition must be one of extreme rarity, and for that reason he has thought it worthy of presentation to this Association.

## SO-CALLED CONGENITAL DISLOCATION OF THE SHOULDER POSTERIOR SUBLUXATION\*

BY ALFRED S. TAYLOR, M.D.

OF NEW YORK, N. Y.

It is my belief that there is no such condition as congenital posterior dislocation of the shoulder.

Inasmuch as a number of isolated cases have been reported in various journals under this heading, and especially since one well-known surgeon and author has, within the last few years, published a series of papers attempting to prove that birth palsies of the upper extremity are due to such a congenital posterior displacement of the shoulder, it seems worth while to present the evidence against the occurrence of such a lesion, and to try to account for the deformity existing in the cases so reported. It is a striking fact that in each of the cases reported as congenital dislocation there has been evidence of disturbance of the motor nerve supply of the extremity. This disturbance has varied in severity and permanence in the different cases, exactly as in birth palsies of the Erb's type.

Therefore it is the object of this discussion to determine, whether the disability of the extremity is due to primary injury of the shoulder with secondary involvement of the nerves, as is maintained by Thomas, of Philadelphia,<sup>5</sup> and his followers,<sup>6</sup> or is due to primary injury of the nerves entering into the brachial plexus.

Against the occurrence of posterior dislocation of the shoulder at the time of birth are the following facts:

There is no recorded case in which the posterior dislocation of the shoulder was found at birth. Since 1914, when Thomas read his paper at the New York Academy of Medicine, I have been looking with especial care at shoulders in these cases and have never found any degree of posterior displacement in a child less than six weeks old. Unfortunately these cases are not usually referred for a surgical opinion until they are several weeks or months old. During the period January, 1914, to April, 1921, there were in my private files records of seventy cases of birth palsy, in all but two (9 and 45, Table 1) of which the condition of the shoulder was carefully noted. Of these sixty-eight cases, twenty-two showed not the slightest degree of posterior displacement of the shoulder. Their ages varied from two days to nineteen years. In the remaining forty-six cases posterior displacement was present in varying degree. Not one of these forty-six cases was less than six weeks old and forty-five of them were eight weeks or more old.

Of the whole sixty-eight only twelve cases were six weeks or less in age. Four were six weeks old, of whom one showed posterior dislocation. In not a single one of the remaining eleven was there any degree of posterior

\* Read before the American Surgical Association, June 16, 1921.

TABLE I.

Date.	Name.	Pre-sen-tation.	Age.	Side and Degree.	Dis loc.	Op.	Findings.	Remarks.
1. Jan. 30 1914 June 28 1917	Green Green	V V	3 wks. 3.5 yrs.	R++++ R++++	0 +	0 July 2 1917	v & vi torn vii cicatricial	
2. Mar. 14 1914	Plumb	V	3 yrs.	L++++	+	Mar. 23 1914	v, vi, vii posterior disc. disappeared 9 months after op.	
3. July 7 1914	Lefferts	V	3 wks.	L++++	0	Nov. 25 1914	v torn off vi and vii cicatricial.	
4. Dec. 5 1914	Kachinsky	?	3 mos.	L+	+	0		
5. Jan. 4 1915	Earnest	V	8 mos.	R+	+	0		
6. Jan. 18 1915	Hollander	V	5.5 yrs.	L++	+	Jan. 18 1915	v ruptured vi cicatricial	
7. Nov. 10 1915	Klein	Br.	6 mos.	R++++ eye	+	Nov. 10 1915	v almost torn off vi torn comply vii damaged viii & i avulsed.	
8. Jan. 31 1916	Warner	V	9 wks.	R++++ eye	0  1 yr. later	Mar. 1 1917 Apl. 4 1917	Stopped because hemorrhage v, vi, torn across No Sever vii cicatrized viii & i avulsed Post. disc. gone on May 15 '18 except on strong effort to elevate arm forward.	
9. May 17 1916	Joyce	V	10 mos.	L+++++	?	May 17 1916	v, vi, vii torn & cicatric. viii & D i avulsed.	
10. Nov. 10 1916	Whiting	V	3 mos.	R+++++ eye	+	0		
11. Feb. 2 1917	Kilpatrick	V	2 mos.	L++++	0	0		
12. Feb. 12 1917	Dennis	Br	2 days	R+	0	0		
13. Mar. 6 1917	Rigby	?	12 yrs.	R+++++	+	Mar. 12 1917	v, vi, torn across. Sep. 1 cm., bulbous, vii 2-3 damaged, viii & i scar pressure.	
14. Mar. 19 1917	Delprate	V	6 wks.	R++++	0	0		
15. Apr. 27 1917	Lillicrapp	V	8 mos.	L+++	0	0		
16. June 2 1917	Barry	V	6 mos.	L+++++ eye involved	+	June 5, 1917	Long scar v, vi, vii, viii Di	2nd op. Nov. 18, 1919
17. Sept. 4 1917	Christ	V	2 mos.	R+ v & vi	+	0		Made a complete spontaneous recovery with reduction of the subluxation

TABLE I.—Continued.

Date.	Name.	Pre-sen-tation.	Age.	Side and Degree.	Dis loc.	Op.	Findings.	Remarks.
18. Oct. 17 1917	Weaver	V	5.5 yrs.	R++++	+	Oct. 26 1917	Sever v, vi about $\frac{1}{2}$ torn vii $\frac{1}{2}$ torn off	
19. Oct. 26 1917	Greenberg	V	4 mos.	R++++ eye	+	o		
20. Dec. 26 1917	Merila	Br.	6 wks.	R++++	+	Apr. 16 1918	v & vi torn	
21. Feb. 1 1918	Dilber	V	3 mos.	L+++	+	Feb. 8 1918	v torn off vi & vii cicatricial viii & Di	
22. Feb. 12 1918	Van Dine	V	3.5 mos.	R++++	+	Apl. 11 1918	v, vi, vii re-acted No Sever 2 yrs. later, almost compl. reduc-shoulder spont.	
23. Apr. 6 1918	Carey	V	3 $\frac{1}{4}$ mos.	L++	+	Apl. 6 1918	cv torn off	almost perfect recovery
24. Apr. 30 1918	Sloben	V	10 days	L++++	o	o		
25. May 17 1918	Eskwith	V	2 $\frac{1}{2}$ yrs.	R+	+	o		
26. June 4 1918	Porta	V	3 mos.	L+++	+	o		
27. June 17 1918	Corbally	?	14 yrs.	L++	+	Nov. 30 1918	C v & vi	
28. June 17 1918	Tetamore	Br.	2 wks.	R+++	o	o		
29. June 20 1918.	Fitzgerald	Br.	7 wks.	L+ R++	o o	o o		
30. June 27 1918	Silverman	V	5 yrs.	R+++ eye (very little power)	o	o		
31. Aug. 2 1918	Silvagio	V	2 & 4 mos.	R+++++ eye	+	Dec. 14 1918	v, vi, vii, viii & i damaged Died of hem-orrhage on table.	
32. Nov. 14 1918	Rosenbloom	V	26 mos.	R+++	+	o		
33. Nov. 15 1918	Margules	V	2 $\frac{1}{2}$ yrs.	R+++.	+	June 1918	Op. done by another sur-geon who ex-posed plexus but did not attempt any repair.	
34. Feb. 6 1919	Carlson	V	2 $\frac{1}{4}$ yrs.	R+	+	Feb. 19 1919	C v & Vi	
35. Feb. 20 1919	Zucker	?	19 yrs.	L++++	o	o		
36. Mar. 7 1919	Kalmanowitz	V	2 mos.	R++++	+	o		
37. Apr. 23 1919	Levas	Br.	4 mos.	R+++	+	o		
38. Apr. 29 1919	Rubino	V	22 mos.	R++++	+	June 2 1919	v, vi, torn across vii torn almost across viii torn across D.i normal.	

TABLE I.—Continued.

Date.	Name.	Pre-sen-tation.	Age.	Side and Degree.	Dis loc.	Op.	Findings.	Remarks.
39. May 20 1919	Shusteroff	Br.	7 yrs.	R (spontan. cure) L just shoulder remnants compl'y parlyd.	o o	o o		
40. May 26 1919	Nobile	Br.	3 mos.	R + + + +	+	June 7 1919	v, vi & vii torn across, Bulbs; viii & i compressed.	
41. June 17 1919	Allensohn	V	14 mos.	R + + +	+	o		
42. July 21 1919	Rifkin	V	7.5 yrs.	L + + +	+	o		
43. Oct. 16 1919	Nagelsmith	?	16 yrs.	R + + + + + eye	+	Jan. 23 1919	v torn across vi 'almost' vii ganglion of root extra-spinal. viii & i avulsd.	
44. Oct. 30 1919	Waldman	V	19 mos.	L + + + + eye	+	Jan. 26 1920	v, vi, torn apart vii mostly torn apart viii & i cicatricial into foramina. No Sever. Closed reduction: 9 mos. almost no dislocation remaining.	
45. Oct. 30 1919	Lots	Br.	3.5 yrs.	L +	?	o		
46. Oct. 31 1919	Glantz	V	2.5 mos.	R + + + + C viii & Di eye	+	o		
47. Dec. 26 1919	Lonetti	Br.	6 wks.	L + + + +	o			
48. Dec. 31 1919	Bettcher	Br.	7 wks.	R & L + + + R normal in 10 days	o o	o o		
49. Jan. 19 1920	Sately	Br.	9 wks.	L + +	o o	o o		At 4 mos. had post sublux. of shoulder which had disappeared at 9 mos. with improvement of muscles.
50. Feb. 20 1919	Johnson	Br.	8 wks.	R + + +	+	o		
51. Mar. 12 1920	Teall	V	9 mos.	L + + + +	+	Mar. 22 1920	v, vi, vii 2½ cm. dense scar tear viii & i constricted. No Sever. Post-op sub-coracoid dislocation.	
52. Mar. 17 1920	Sable	V	5.5 wks.	R +	o	o		
53. Mar. 24 1920	Johnstone	V	6 yrs.	R + + +	+	Apr. 3 1920	C v & vi half torn through.	
54. Apr. 8 1920	Bernd	V	10 wks.	L + + +	Very slight +	o		

TABLE I.—Continued.

Date.	Name.	Pre-sen-ta-tion.	Age.	Side and Degree.	Dis loc.	Op.	Findings.	Remarks.
55. Apr. 23 1920	Post	V	2 days	L+	o	o		
56. May 17 1920	Cucumber	V	7 mos.	L++++	+	o		
57. June 9 1920	Everson	V	15 mos.	L+++ Cviii & Dieye	+	o		
58. June 23 1920	Ackerholt	V	5 mos.	R++++ eye small	Very slight +	o		
59. Oct. 18 1920	Conroy	V	5 yrs.	R+ mild	+	o		
60. Oct. 20 1920	Mauersberger	V	10 mos.	R++	+	o		
61. Oct. 21 1920	McLoughlin	V	16 mos.	L++++ eye.	+	Mar. 23 1921	v. vi, vii, viii & Di torn & cicatrical.	Eye showed slight enophthalmos and narrowed palpebral fissure suggesting avulsion of Di & Cviii. Hand also flabby and contracted.
62. Nov. 16 1920	Weinberg	V	5 days	L+++	o	o		
63. Nov. 29 1920	Levine	V	2½ mos.	R++++	+	o		
64. Dec. 9 1920	Blackman	V	4-5 mos.	R++++	+	o		
65. Jan. 19 1921	Feltman	V	6.5 mos.	L++++	+	o		
66. Jan. 23 1921	Cooper	V	6 wks.	L+++	o	o		
67. Feb. 9 1921	Kirschbaum	V	2 mos.	L++++ eye involved	+	o		
68. Mar. 1 1920	Mooney	V	2.5 years	R++	o	o		Pectoralis major atrophied and not contracted.
69. Mar. 18 1921	Benedito	V	2 mos.	R++++	o	o		
70. Mar. 20 1921	Osterman	V	14 mos.	L++++ eye sl. invol- ved.	+	o		

## Key.

Vertex = V.  
 Breech = Br.  
 Unknown = ?  
 Date = First time seen.  
 Age = Age at first observation.  
 Side & Degree = + to +++++ indicating in a general way the degree of disability.  
 Eye or Eye involved = Narrowed palpebral fissure. (Same side as palsy) slight enophthalmos, and smaller eye, usually indicating injury of C vii & Di close to foramina, or avulsion from cord.  
 Dislocation = + = present. (Sometimes absent at first exam. and present some weeks later.)  
 = o = absent.  
 = o = not done.  
 Operation = when done = Date of operation.  
 Findings v, vi, vii & viii = Cervical nerves. Di = Dorsal nerve.  
 "Constricted" = Nerves compressed by scar tissue.  
 "Sever" and "No Sever" indicate whether or not pectoralis major and subscapularis were divided to get reduction of dislocation.  
 Torn and cicatrical nerves resected and sutured, constricted nerves freed.



## CONGENITAL DISLOCATION OF THE SHOULDER

displacement. Diligent inquiry among the obstetricians in three of the large lying-in hospitals in New York City elicited the fact that not one of them had ever seen a posterior subluxation of the shoulder *at the time of birth* in any one of the birth palsies of Erb's type which had occurred in their services.

Dr. Edward D. Truesdell, connected with the New York Lying-in Hospital, saw every case of birth injury of whatever type during a period of ten years, and involving about 30,000 deliveries, and in all injuries of extremities made röntgenograms at intervals. In a personal communication he states that among the thousands of infants delivered there were many cases of birth palsy of Erb's type, but that he never saw a single one in which there was any degree of dislocation of the shoulder. During this period he was getting the material for his admirable book on "Birth Fractures and Epiphyseal Dislocations," so that he examined these shoulder joints with minute care. He is a well-trained surgeon and therefore a competent observer. Incidentally he states that there was never epiphyseal separation of the upper humerus associated with Erb's palsy in his experience.

Dr. H. McM. Painter, for years connected with the obstetric division of the Nursery and Child's Hospital and the Sloane Maternity Hospital, verbally states that he has never seen a birth palsy with an associated posterior subluxation of the shoulder *at birth*, and that he has called in another surgeon in every injury case in order to check up his own findings.

A diligent search over a period of seven years has failed to find a single authentic case in which a birth palsy has been associated *at birth* with any degree of posterior displacement of the upper end of the humerus. Even Thomas, who has built up his theory that "birth palsy is the result of posterior dislocation of the shoulder, with secondary nerve injury, rather than the result of primary plexus injury," states that he has never happened to see a posterior dislocation present in an infant less than three weeks old. The paralysis, on the contrary, is present in all cases at birth.

From the evidence presented, it is fair to conclude that there is no such condition as "congenital posterior dislocation of the shoulder" and therefore it cannot be the cause of the "birth palsy of Erb's type." The term congenital, in this connection, should be discarded.

Nevertheless, in the sixty-eight children above tabulated (Table 1) some degree of posterior dislocation of the shoulder was present in forty-six (or 68 per cent.). The youngest child to show it was six weeks old. There were sixty children in the series six weeks or more of age, and of these forty-six (or 77 per cent.) showed the dislocation. If no dislocations appear until the age of six weeks, and above that age appear in 77 per cent., the deformity must develop as a sequel to the primary injury causing the paralysis, which is unquestionably damage of the brachial plexus.

The conviction that injury of the brachial plexus is the primary cause of the paralysis results from consideration of the following facts:

The paralysis is present at birth. Dislocation is absent.

The distribution of the paralysis is always characteristic of a *root* lesion

rather than a lesion of peripheral trunks after they leave the plexus, which latter would be the case if the paralysis resulted from injury secondary to shoulder dislocation. The distribution of the paralysis in Erb's palsy is so characteristic that a little familiarity enables one to predict fairly accurately which roots are damaged in a given case.

In a considerable number of operations (seventy-six in my private files, including also cases 1903-1904) the lesion in the great majority of cases involved the upper roots of the plexus chiefly, and there was a relatively wide area of normal tissues between it and the region of the shoulder joint and there was no cicatricial tissue in the axilla. In only a very few cases in which the entire plexus was damaged did the resulting cicatricial tissues extend downward to the shoulder joint region.

Thomas states that no case is on record where, at operation, a lesion of the nerves was found other than cicatricial induration which he believed was secondary to shoulder joint injury. In the October, 1905, *American Journal of Medical Sciences* (Clark, Taylor and Prout), Case III, it was recorded that the outer trunk coming from the junction of the fifth and sixth roots was torn off and displaced downward and inward 2.5 cm. and was adherent to neighboring muscle.

In the series of seventy cases seen since 1914, twenty-five were operated upon, and reference to the findings shows (Table I) that in many instances nerves were more or less completely torn across.

This type of injury could not possibly result from cicatricial infiltration of nerves secondary to injury of the shoulder joint (Figs. 1 and 2).

In two cases, No. 43 in the above group, and an infant named Passamero, operated upon at the Babies' Hospital in October, 1912, a posterior root ganglion was present in the cicatricial tissue well external to the foramina. This indicated avulsion of roots from the cord.

Through the courtesy of Drs. L. A. Wing and Losee of the Lying-In Hospital, the following case is put on record:

Mila. Confinement No. 77647. Born December 15, 1920. It was a Footling presentation, with threatened prolapse of the cord. Breech extraction was rendered difficult by a moderately contracted pelvis. No instruments were used. The general condition was good for twenty-four hours, after which signs of intracranial injury appeared and death occurred on the fifth day.

At birth, paralysis of both upper extremities was noted.

*Right side:* There was a fracture of the clavicle. The entire extremity showed flaccid paralysis except for very slight movement in the fingers.

*Left side:* There was complete flaccid paralysis. Autopsy showed extensive intracranial hemorrhage, with extension of the clot down the spinal canal; fracture of the right clavicle; *both shoulder joints perfectly normal*; both brachial plexuses macroscopically normal outside the intervertebral foramina, and avulsion of the roots of C iv and v from the cord on the left side. These roots lay outside of the dura. (See Figs. 3 and 4.)

The case of Boyer\* is equally convincing and more interesting.

On July 4, 1905, during an attempt to deliver the aftercoming head through

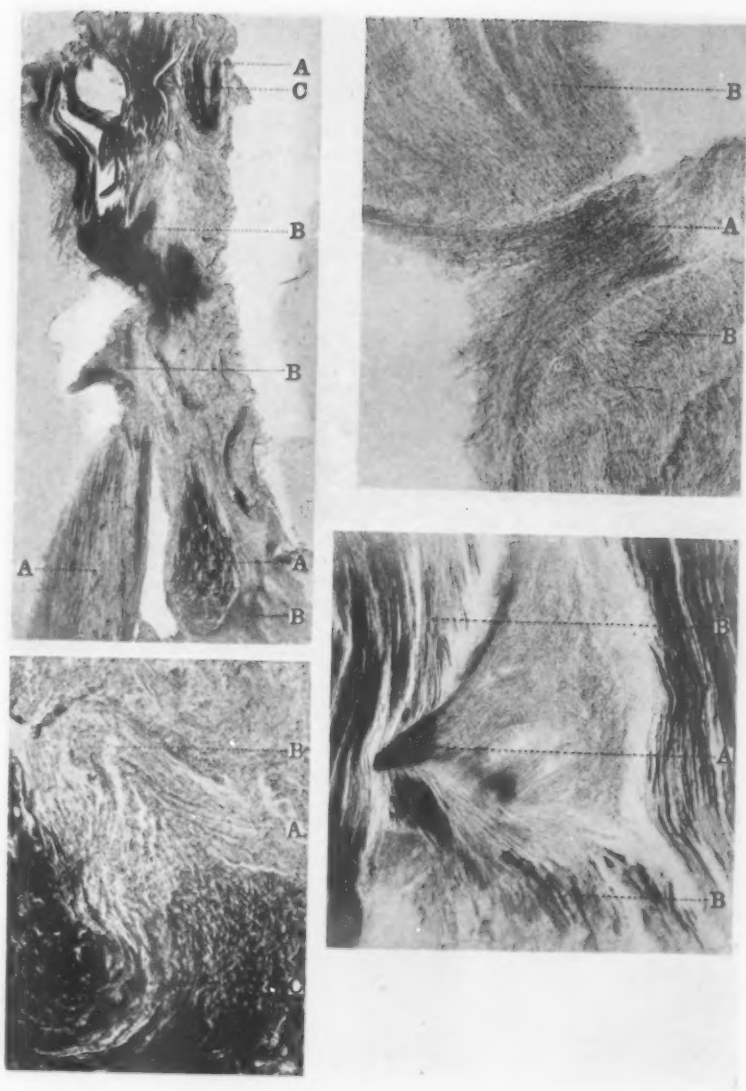


FIG. 1.—These are microphotographs of nerves resected in the early cases of the operative series. The lesions were all located between the intervertebral foramina and the distal end of the plexus. No mere infiltration of the nerves by material from an injured shoulder joint (as suggested by Thomas) could possibly cause the results pictured. The very black lines represent nerve fibres more or less damaged and the rest is cicatricial tissue.

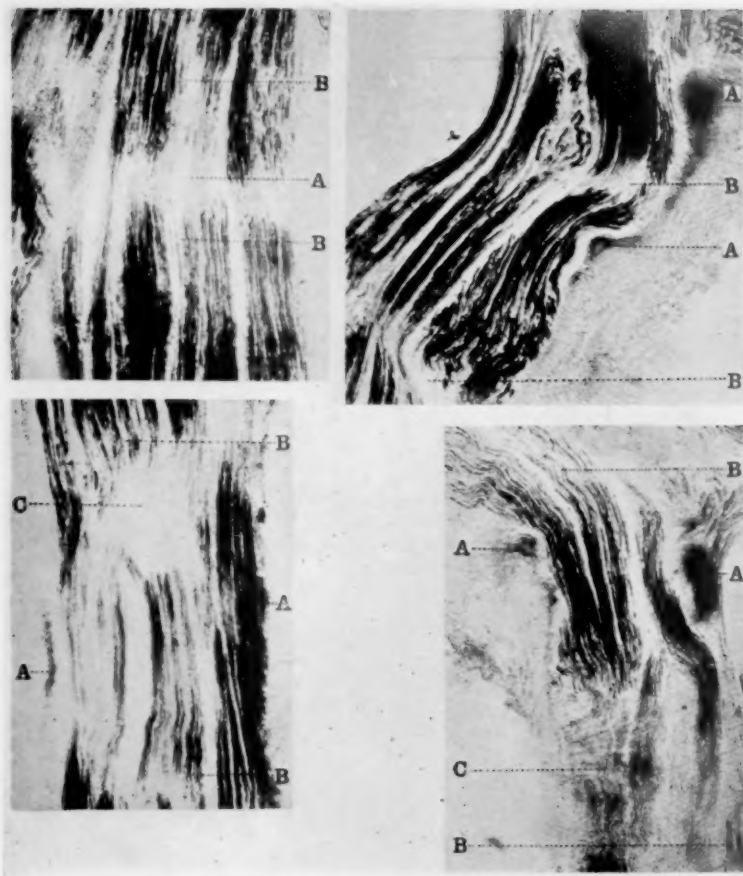


FIG. 2.—These are microphotographs of nerves resected in the early cases of the operative series. The lesions were all located between the intervertebral foramina and the distal end of the plexus. No mere infiltration of the nerves by material from an injured shoulder joint (as suggested by Thomas) could possibly cause the results pictured. The very black lines represent nerve fibres more or less damaged and the rest is cicatricial tissue.

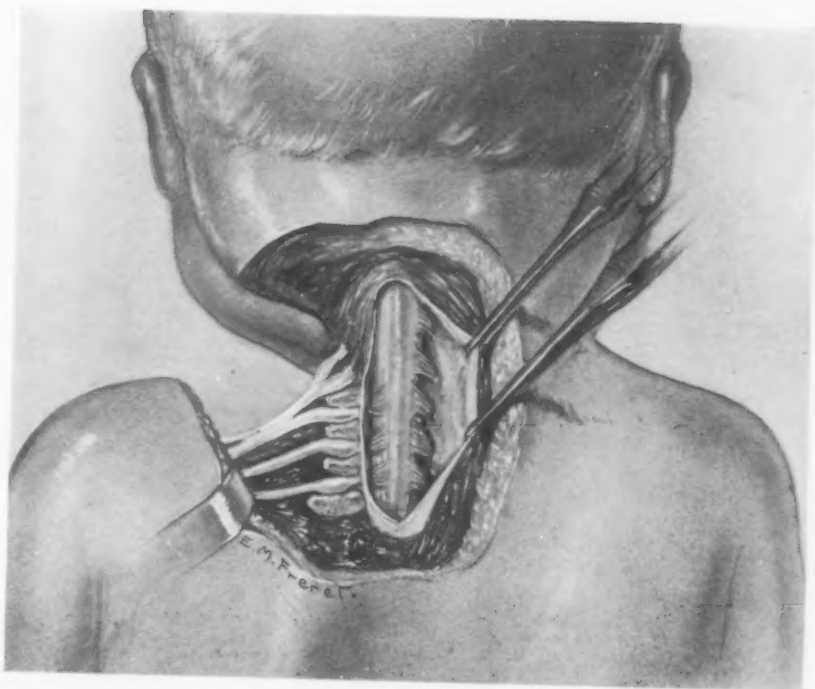


FIG. 3.--The subject was injected with and submerged in ten per cent. formalin solution. The plexus and spinal cord are exposed by dissecting away the soft tissues, removing the posterior-vertebral arches, and opening the dura. Note all the roots present on the right side of the cord and that two C. IV and V have been avulsed from the cord on the left side, including both sensory and motor roots. The torn ends of the two roots were extradural. The cord itself was so smooth that the actual site from which the posterior roots were avulsed could not be seen. There was no apparent injury to or deformity of the cord.



FIG. 4.--Same infant as in FIG. 3, showing the left brachial plexus apparently intact in its extraspinal portion. The right plexus also appeared normal extraspinally.



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a contracted pelvis, the right plexus was felt to give way under the finger, passing over the right shoulder. A right-sided birth palsy was prophesied before the delivery, and it appeared in typical form when delivery was completed. No posterior dislocation of the shoulder was present and no injury had occurred to the shoulder joint. Two hours after birth a severe convulsion was followed by death. The body was injected with 10 per cent. formalin solution and then was immersed in a jar of similar solution. After complete hardening the right brachial plexus was exposed and excised completely from foramina to upper axilla. A typical lesion from overstretching was present at the junction of the fifth and sixth roots. The pathology present was described and pictured in a micro-photograph by Dr. T. P. Prout in the *Journ. A. M. A.*, January 12, 1907, xlviii, pp. 96-104.

In twenty plexuses (*Am. Journ. Med. Sc.*, October, 1905, Clark, Taylor and Prout) in infants still-born or dying shortly after birth, typical lesions were produced by forcible separation of the head and neck from the corresponding shoulder. It so happened that in seven of the twenty the root of C vi was avulsed from the cord and the ganglion of the posterior root lay outside the spinal foramen.

Avulsion in the experimental cadaveric cases occurred in a much higher percentage than seems to be the case in the clinical series. The percentage is difficult to determine in the clinical series inasmuch as laminectomy would be necessary, and is not justifiable, to decide the question (see Figs. 3 and 4).

These facts taken together prove conclusively that the primary cause of brachial birth palsy is damage to the brachial plexus. The etiology, mechanism and pathology were fully worked out in the original publication in 1905 previously referred to, and nothing in later experience has caused a change in the views there expressed.

Assuming that the primary lesion is a brachial plexus injury, the later appearance of posterior subluxation of the shoulder in 68 per cent. of these children means that there is a distinct cause-and-effect relation between the nerve lesion and the dislocation, which must be worked out for the sake of preventive and curative treatment. (Also see Fairbank.<sup>2</sup>)

In the shoulder joint of the newborn infant the glenoid fossa is very shallow and in some instances is almost convex; the joint capsule is quite loose (Figs. 6, 7, 8 and 10). Therefore, outside of atmospheric pressure which plays a minor rôle, the only structures that hold the upper end of the humerus and the glenoid fossa in their proper anatomical relations are the muscles that pass over and surround the joint. This is the view generally held by anatomists. Through the courtesy of Dr. Lucius Wing of the visiting staff of the New York Lying-In Hospital, an interesting demonstration of the above fact was possible. Some twenty infants were examined. When they were asleep and the shoulder muscles completely relaxed, the upper end of the humerus could be displaced backward, forward, outward or downward with ease, for a distance of 1 to 2 cm.; but as soon as the infant woke up and resisted, none of these displacements was possible except by the use of undue violence.

If the muscles surrounding the shoulder joint are responsible for the main-

tenance of correct anatomical relations between the two bones entering into it, then it follows that the activities of the various muscles must be very nicely balanced against each other in order always to hold the two bones properly together in the various attitudes of the joint. It would therefore be expected that if one or more of these muscles were paralyzed, while others remained active, the balance would be so disturbed that deformity of some sort would result. If the muscles involved were only partially paralyzed the disturbance of balance might be so slight that no displacement would result. If all the muscles were partially paralyzed to the same degree there would be loss of strength in the joint but no disturbance of balance and no displacement would occur. If all the muscles were completely paralyzed there would be complete loss of power, a flail joint would result and gravity would determine the displacement.

In a series of children with birth palsies one can always find examples of these various degrees of disturbed balance. Except in flail joint the displacement in nearly every case is backward, quite the opposite of the usual traumatic dislocation of the shoulder.

The most marked dislocations have in this series been observed in the older children where complete paralysis of the spinati and teres minor had persisted and where biceps and coraco-brachialis had regained considerable power, as had also pectoralis major and subscapularis but in these last two there had developed marked contracture.

The mechanism of the posterior displacement is as follows:

The infraspinatus and teres minor form the chief posterior buttress of the shoulder joint and, being innervated by two upper roots of the plexus, they usually suffer the most complete and lasting paralysis. Pectoralis major, teres major and latissimus dorsi being only partially paralyzed rotate the humerus inward, and thus overstretch the paralyzed posterior muscles. Teres major and latissimus dorsi also exert traction backward on the humerus. When subscapularis partly escapes paralysis or regains its function it also causes inward rotation and slightly backward traction on the humerus (Fig. 6). Pectoralis major and subscapularis being only partially paralyzed and having only paralyzed antagonists first undergo functional shortening and then organic contracture. The head of the humerus is thus gradually forced backward, overstretching to a still greater extent the paralyzed posterior muscles.

Finally, when the posterior subluxation is present, it is greatly exaggerated during attempts of the patient to elevate the extremity. Pectoralis major, coraco-brachialis, and biceps, when it has recovered somewhat, carry the humerus forward and upward, but at the same time cause a thrust upward and backward along its longitudinal axis, which visibly increases the subluxation of the head of the humerus.

In a small number of cases it has been stated that while a well-marked posterior subluxation of the shoulder is present, all the muscles of the extremity react to the faradic current, that therefore there is no persisting

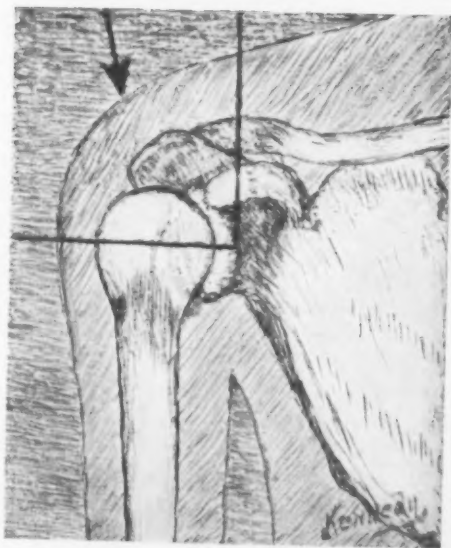


FIG. 5.--Shows the planes of section of the right shoulder in very young infant. The right-angled upper outer portion of the shoulder was removed en bloc giving the exposure for FIGS. 6, 7 and 8.

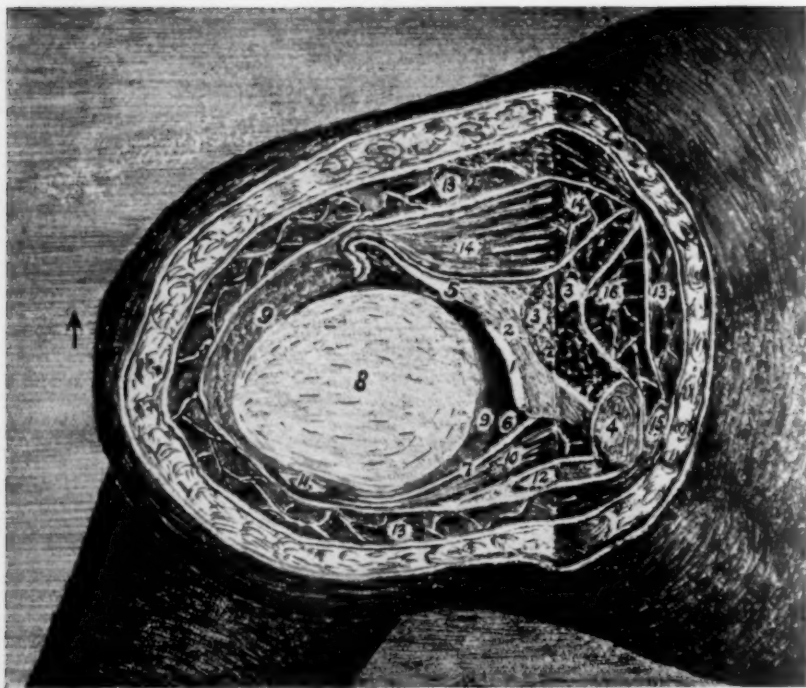


FIG. 6.--The arrow indicates that the humerus is rotated outward, showing relaxation of posterior capsule and muscles. 1. Glenoid cavity. Note the nearly flat contour. 2. Cartilaginous bed of glenoid. 3. Scapula, showing ossification. Note shapes of cartilaginous bed and ossified portion of scapula. 4. Caracoid process. Sectioned obliquely. 5. Posterior border of glenoid cartilage merging into posterior capsule. 6. Inferior portion of capsule. 7. Anterior capsule. 8. Head of humerus, sectioned horizontally (See FIG. —). 9. Serous surfaces of head of humerus with deltoid bursa externally. 10. Subscapularis muscle. Note that it pulls somewhat backward as well as inward. 11. Biceps tendon, long head. 12. Biceps, short head, and caraco--brachialis. 13. Deltoid muscle. 14. Infraspinatus muscle. 15. Clavicle. 16. Supraspinatus muscle.

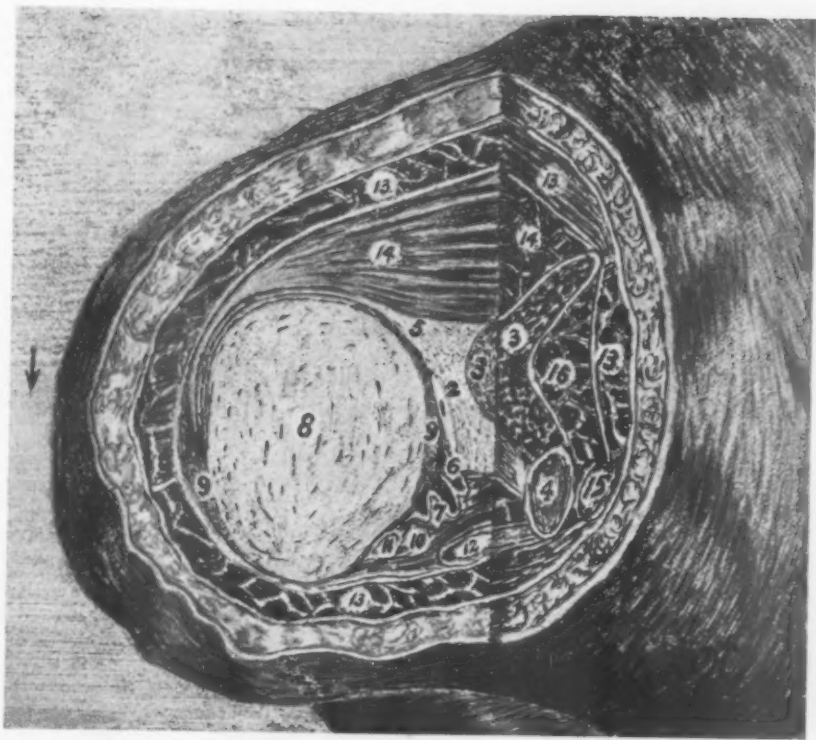


FIG. 7.—Arrow indicates rotation inward of the humerus, showing stretching of the posterior structures, and relaxation of the anterior capsule and subcapularis muscle. The portion of glenoid cartilage at 5, is very flexible and causes practically no obstruction to posterior displacement of the head of the humerus.

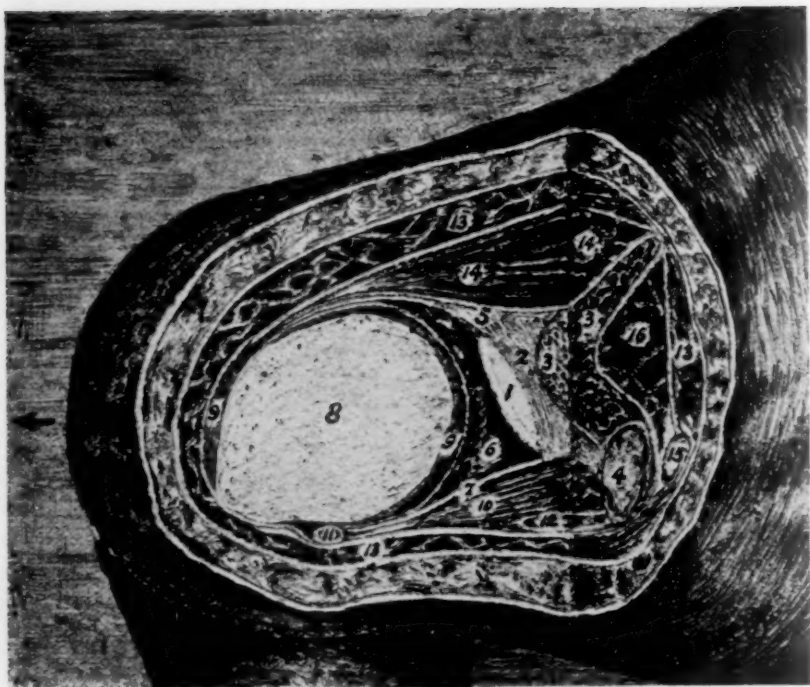


FIG. 8.—Arrow indicates pull outward on head of humerus by manipulating the shaft of the bone. Note the wide separation of the joint surfaces even in the face of rigor mortis. Numbers are the same as in FIG. 7.



## CONGENITAL DISLOCATION OF THE SHOULDER

paralysis, and therefore the dislocation cannot be the result of a paralysis due to nerve injury. Since this apparently paradoxical condition is seen only in children one or more years old, it can readily be accounted for on the basis of the mechanism previously presented.

The dislocation appears usually in from six weeks to three months, and is always associated with marked inward rotation of the humerus, and with contracture of the pectoralis major and subscapularis. These contractures are usually so marked that the humerus cannot be rotated outward passively, even by the use of much force, so that the flexed forearm will come to the sagittal plane, *i.e.*, less than 50 per cent. of its normal. Therefore the external rotators are continuously overstretched, and even if nerve supply regenerates sufficiently to give faradic reaction, they nevertheless suffer a constant relative handicap, the muscular imbalance persists and the dislocation remains. If in addition the coracoid has grown forward and downward it adds a permanent obstacle to spontaneous reduction. The persistence or disappearance of the dislocation depends upon whether or not the external rotators can overcome their handicap, and whether or not the coracoid interferes. The majority of them persist.

A number of very young infants have been seen with birth palsy in whom no sign of dislocation was present. After several weeks or months, during which parents have failed to follow advice, they have again appeared with definite posterior displacements. Warner<sup>8</sup> and Sately<sup>49</sup> in this series.

In one case in this series Sately,<sup>49</sup> first seen at nine weeks of age, showed no dislocation; at four months showed definite posterior displacement, and then, going on to a spontaneous nerve and muscle regeneration, returned at nine months with no sign of posterior displacement. This is perhaps the most convincing argument of all that the displacement is the result of disturbing the balance in the action of the shoulder joint muscles.

In several cases of this series where well-marked dislocation was present before operation, and where at operation nothing except a nerve repair was done, post-operative recovery of the nerves and associated muscles has been accompanied by a spontaneous gradual reduction of the displacement.

Van Dine,<sup>22</sup> Warner,<sup>8</sup> Plumb,<sup>2</sup> Waldman.<sup>44</sup> Table I.

It therefore seems fair to deduce from the material presented that there is no such entity as congenital posterior dislocation of the shoulder, and that in the cases so reported the dislocation is a delayed sequel of a primary nerve injury, which has caused an unevenly distributed paralysis in the muscles about the shoulder joint. The resulting unbalance leads to the development of the dislocation.

Treatment is primarily prophylactic, for this dislocation need not occur if the paralyzed extremity is properly treated from the beginning. Maintenance of correct posture is fundamental, as this prevents both the overstretching of the paralyzed muscles and the contracture of the non-paralyzed or partially paralyzed antagonists. The best posture consists in abduction of the arm to 90 degrees or more, external rotation of the humerus until the

flexed forearm is in the vertical plane, flexion of the elbow to 90 degrees or less, complete supination of the forearm, and extension of the wrist and fingers (Fig. 11). This posture is almost perfectly attained if the palm of the opened hand is held on the vertex of the skull with the elbow held out in the transverse plane of the body, and may be maintained by any one of a great variety of methods. Moreover this posture helps mechanically to prevent posterior displacement of the shoulder, and causes relaxation of the nerves which have been damaged by overstretching and so favors their spontaneous recovery to the maximum degree. After the first two or three weeks, during which manipulation is very painful, the extremity should be removed from its fixation two or three times a day and given massage and passive motion.

In appropriate cases, at the proper time, surgical repair of the damaged nerves should be done. There is much and heated argument as to what cases are appropriate and what time is proper for surgical repair, and the question is by no means settled. The author's opinion is a matter of repeated record, and is modified by later experience only to the extent that a longer period between birth and operation is permissible provided correct care, as above indicated, is continuously given.

In those cases in which the dislocation has occurred it may be readily reduced by the method of Sever.<sup>8</sup> Nerve repair may be done at the same time. Whitman's method, which consists in stretching, rather than cutting, the contracted muscles, followed by fixation, is not so satisfactory, as there is a strong tendency to recurrence of the dislocation. Moreover, in many of the cases the tip of the coracoid process has become elongated forward, and especially downward, so as to mechanically interfere with complete replacement of the head of the humerus. This elongated tip must be resected subperiosteally to attain the best result. Occasionally it is also necessary to do osteoplasty on the acromion process because of a similar distorted overgrowth.

In any case, whether operated upon or not, the fixation and physical therapeutics above outlined must be continued until the paralyzed muscles and damaged nerves have recovered sufficiently to prevent the muscular imbalance which would otherwise result in posterior subluxation.

#### SUMMARY

Since there is no case on record where in a birth palsy case a posterior subluxation of the shoulder has been found *at birth*—since obstetricians connected with three of the large lying-in hospitals of New York City have never seen a single instance of the association of the two at birth; since, after a search during seven years, the author has never been able to find posterior subluxation in any birth palsy case less than six weeks old—he is forced to believe that “congenital posterior subluxation of the shoulder” does not occur in birth palsy cases and therefore cannot be the cause of the palsy.

The term “congenital” should be discarded in this connection.



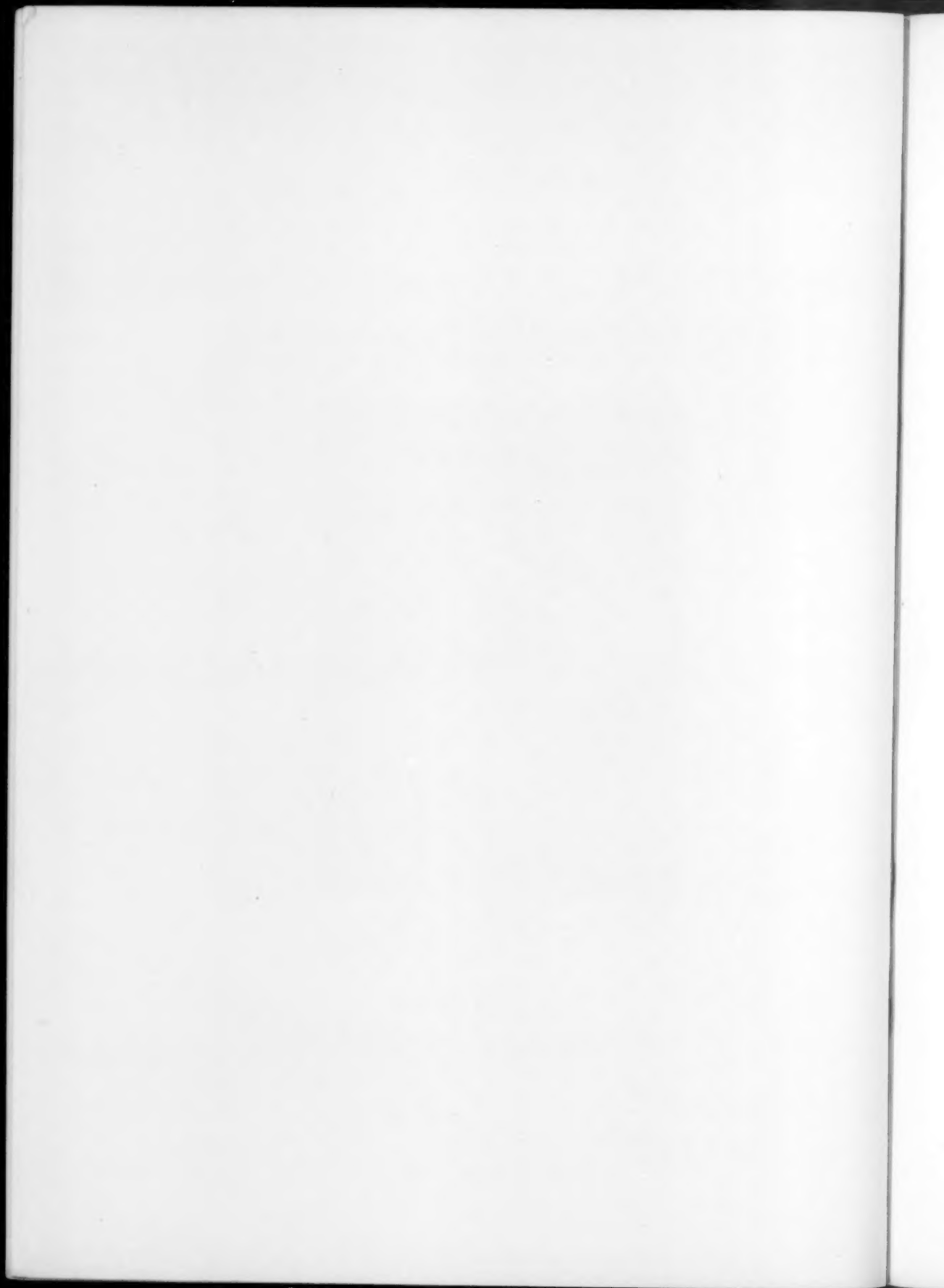
FIG. 9.—The arrows show the effect of pull on the posterior portion of capsule and glenoid cartilage, indicating how slight is the resistance to posterior displacement of the head of the humerus.



FIG. 10.—Left shoulder, in very young infant with muscles lifted away and head of humerus pulled outward, showing free displacement without injury to capsule. (The muscles are the chief factors in maintaining the joint surfaces in proper contact in the different attitudes of the extremity.) 1. Head of humerus drawn laterally and downward. 2. Coracoid process. 3. Lateral end of clavicle. 4. Acromium. 5. Glenoid cavity. Anterior margin. 6. Tendon of short head of biceps and Coraco-brachialis M. 7. Tendon of long head of biceps. 8. Tendon of Pectoralis minor. 9. Tendon of Triceps M. 10. Deltoid muscle turned back. 11. Deltoid bursa. 12. Anterior portion of capsule. 13. Coraco acromial ligament. 14. Superior portion of capsule.



FIG. 11.--Shows an older child held in the desired position by the author's brace. This happens to be a post-operative case and therefore the head is harnessed to prevent traction on the sutures.





## CONGENITAL DISLOCATION OF THE SHOULDER

Since the author's series shows no dislocation present up to six weeks of age, but shows its presence in 77 per cent. of the sixty cases six weeks or more old, it is obvious that the dislocation is a sequel of the paralysis.

That the paralysis results from nerve injury is evidenced by these facts:

Nerve lesions have been found and resected in a large number of operative cases (Figs. 1 and 2), where they could not have been the result of injury to the shoulder. The area of cicatricial nerve damage was widely separated from the shoulder joint structures which appeared of normal texture except for the contracture in some of the anterior muscles.

The nerves were torn across, avulsed from the cord, or shredded and cicatrized.

Lesions precisely similar to those found at operation have been experimentally produced on the infant cadaver.

In one case the plexus was felt to give way under the author's fingers and at birth there was a typical palsy; no disturbance of the shoulder was present, and autopsy showed a nerve lesion precisely similar to the experimental and operative ones.

Figs. 3 and 4 show a distinct nerve lesion in a case of bilateral palsy, where neither shoulder showed dislocation or other injury, either clinically or at autopsy.

The posterior dislocation is a sequel to the unbalanced paralysis of the shoulder muscles, and may be prevented in most cases by proper treatment.

The external rotators (posterior muscles) suffer the most complete paralysis, and are continuously overstretched by the internal rotators which are usually not completely paralyzed and eventually develop organic contracture, with the result that the head of the humerus is gradually displaced backward.

Treatment of the dislocation is:

*Preventive.*—By maintaining correct posture and using physical therapeutics from the time of birth until the muscle balance is sufficiently restored.

*Surgical.*—Nerve repair when indicated, supplemented by the Sever operation when the dislocation is irreducible. These operations are to be followed by postural treatment and physical therapeutics until the muscle balance is sufficiently restored.

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- <sup>2</sup> Fairbanks, H. A. T.: Birth Palsy; Subluxation of the Shoulder Joint in Infants and Young Children. *Lancet*, London, May 3, 1913.
- <sup>3</sup> Sever: *Am. Jr. Dis. of Children*. December, 1916.
- <sup>4</sup> Boyer: Proceedings of the Royal Society of Medicine, Neurological Section, November 23, 1911, page 31. (Report of Pathological Specimen in an adult about forty-five years old, showing avulsion of roots and damage of the cord.)
- <sup>5</sup> Thomas, T. T.: *Am. Jr. of Obstetrics and Diseases of Women and Children*, vol. lxxiii, No. 4, 1916.
- <sup>6</sup> Ashhurst: *Bull. of Med. Dept. of Univ. of Maryland*, 1917.

## STANDARDIZED RESULTS OF WOUND HEALING\*

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THIS study is an attempt to systematize the records of wound healing by the adoption of a standard which aims at a greater degree of accuracy than usually obtains. It also seeks the causes of imperfect wound healing and to correct such accidents.

Our studies have extended over a period of years and the methods we now employ represent the successive stages of what we believe is a more correct method of investigation. In our early attempts a graphic chart of the weekly results was kept, but later abandoned for a monthly record which more nearly eliminates the statistical fallacies.

The facts and figures which we now present are based on the monthly record from January 1, 1920, to July 1, 1921. They represent only a small portion of our clinical material, as it was thought wisest to stand or fall by a limited group of what might be called ideal cases, that is, presenting no conditions of possible infection from the disease itself. For this record, therefore, all such cases as acute appendicitis, any form of salpingitis, any wound that is drained, is not included in our computation. Originally we graded the operations on the stomach and duodenum, but have not included these in our more recent statistics, for it seemed unwise to include these cases which do not represent the same conditions as the bulk of material, more particularly on account of the impaired nutrition of the patients before operation and during convalescence.

Out of 2277 cases admitted to the First Surgical Division only 437 were classified as to wound healing. The main class of cases on which grades were given is as follows: All hernia except strangulated; cholelithiasis without drainage; bones (amputations, open reductions and bone grafts); benign tumors (fibroid uterus, cystoma of ovary, dermoid cyst of scalp); laparotomies for malposition of uterus; adhesions of peritoneum; chronic mastitis; varicose veins; chronic appendicitis, etc.

*Manner of Tabulating Results.*—The material is divided into three groups: Grade I represents absolutely irreproachable wound healing; Grade II small disturbances of wound healing, such as small hæmatoma or trivial infection, but none of these accidents delaying wound healing beyond the usual normal period; Grade III all other cases, that is, all infections.

We feel it is particularly important to differentiate between hæmatomata, classified under Grade II, and infections, Grade III, as the Grade II mishaps

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\* Read before the American Surgical Association, June 15, 1921. Published paper contains figures up to July 1, 1921.

## STANDARDIZED RESULTS OF WOUND HEALING

are more apt to represent individual errors while Grade III may well be laid to a faulty system.

*Manner of Giving Ratings.*—With rare exceptions the ratings are given by me personally. During my absence in the summer no accurate record has been kept of results. Ratings are made on weekly "Field Rounds." If wounds are definitely healed, say at the end of seven or eight days, the grade given is usually final. If the rating is given, say at four or five days, a note is given that the final result must be checked up and is so checked up by me the following week.

These notes are all given in the presence of the Staff at "Field Rounds," and if any possible dissension exists the grade is given according to the consensus of opinion. Occasions for such discussion, however, are almost unknown at present, which indicates that our present system is simple and efficient. At the end of the month results are tabulated as indicated on the charts (Figs. 1 and 2).

In addition to the notes made at the weekly rounds, the results of wound healing are discussed at the weekly staff conference which follows weekly rounds. At this conference explanations for disturbances of wound healing are sought and given and decisions are taken which may influence subsequent procedures. Records are also kept of changes in the staff, both nurses and internes, and the dates of changes of procedures and technic are indicated.

*Results.*—Out of 437 cases classified as to wound healing there were 39 (9 per cent.) with disturbances of wound healing. These were divided as follows: Grade II, 25, or 6 per cent.; Grade III, 14, or 3 per cent.

The following main classifications are given, showing results of wound healing:

Diagnosis	No. of cases recorded	Disturbances of wound healing	Grade II	Grade III
Inguinal hernia .....	172	14 (8 per cent.)	8 (5 per cent.)	6 (3 per cent.)
Chronic appendix .....	90	6 (6 per cent.)	4 (4 per cent.)	2 (2 per cent.)
Bone cases .....	25	4 (16 per cent.)	4 (16 per cent.)	0
Fibroid uterus .....	19	1 (5 per cent.)	0	1 (5 per cent.)
Malposition of uterus ...	14	1 (7 per cent.)	1 (7 per cent.)	0
Femoral hernia .....	13	1 (7 per cent.)	0	1 (7 per cent.)
Incisional hernia .....	12	2 (16 per cent.)	1 (8 per cent.)	1 (8 per cent.)
Varicose veins .....	10	1 (10 per cent.)	1 (10 per cent.)	0
Adhesions .....	8	2 (25 per cent.)	1 (12.5 per cent.)	1 (12.5 per cent.)

It will be noted that the main classes are of inguinal hernia and chronic appendicitis. We have long realized that in inguinal hernia we can expect a moderate number of disturbances notwithstanding our constant efforts to minimize them. Of late we have redoubled our energies as regards preliminary cleansing of the skin of these patients, and our latest technical improvement consists in suturing the aponeurosis to the external oblique with interrupted sutures instead of continuous, thereby lessening the danger of disturbance of the circulation and, in addition, turning in the knots of the sutures toward the deep surface of the wound.

An interesting point is in regard to the removal of the appendix in the course of operations for right inguinal hernia. It is our custom to do so when the appendix can be easily brought into view and its removal performed without possible trauma. The following tabulation is rather interesting in that it does not give support to the view that removal of the appendix is a possible source of contamination. This view, I am informed, was held in the army and at one period orders were issued forbidding this procedure.†

## TABULATION OF HERNIA OPERATIONS

Since January 1, 1917:

	Per cent.
666 hernia with 33 infections .....	4.95
506 hernia without appendectomies—26 infections .....	5.13
160 hernia with appendectomies—7 infections .....	4.37
203 right hernia without appendectomies—14 infections .....	6.89
303 left hernia—12 infections .....	3.96
363 right hernia—21 infections .....	5.78
One case of acute appendicitis with small abscess was removed through hernial wound. Primary union.	
One case of abscess base of appendix opened above. Hernial wound healed by primary union.	

*Other Factors.*—A study also is being made of the results according to the nationality, age and sex of the patient. So far we do not feel justified in drawing any conclusions. We find that at present 80 per cent. of our patients are foreign born, and it will be readily understood that, as these patients include many recent immigrants, standards of health, nutrition, and cleanliness must be somewhat lower than we would desire.

*Preparation of the Skin.*—Since the fall of 1918 we have replaced tincture of iodine by picric acid 5 per cent. alcoholic solution and continue to be well pleased with it. We believe our results justify our confidence in its antiseptic qualities and its use has been entirely free from the occasional irritation produced by tincture of iodine. Moreover, we have reason to believe that picric acid, if carried into the peritoneum, causes less damage than tincture of iodine.‡

In employing picric acid we have no hesitation in using "wet preparation" and the patients are scrubbed and shaved with soap lather. With the exception of hernia, no other form of antiseptic is used.

† Information furnished by Dr. W. A. Downes.

‡ "The Advantages of Picric Acid Over Tincture of Iodine for Disinfection of Skin," Charles L. Gibson. *ANNALS OF SURGERY*, February, 1919.

"Picric Acid in Operative Surgery," Charles E. Farr. *ANNALS OF SURGERY*, January, 1921.

"The Results of Operations for Chronic Appendicitis," Charles L. Gibson. *American Journal of the Medical Sciences*, May, 1920.

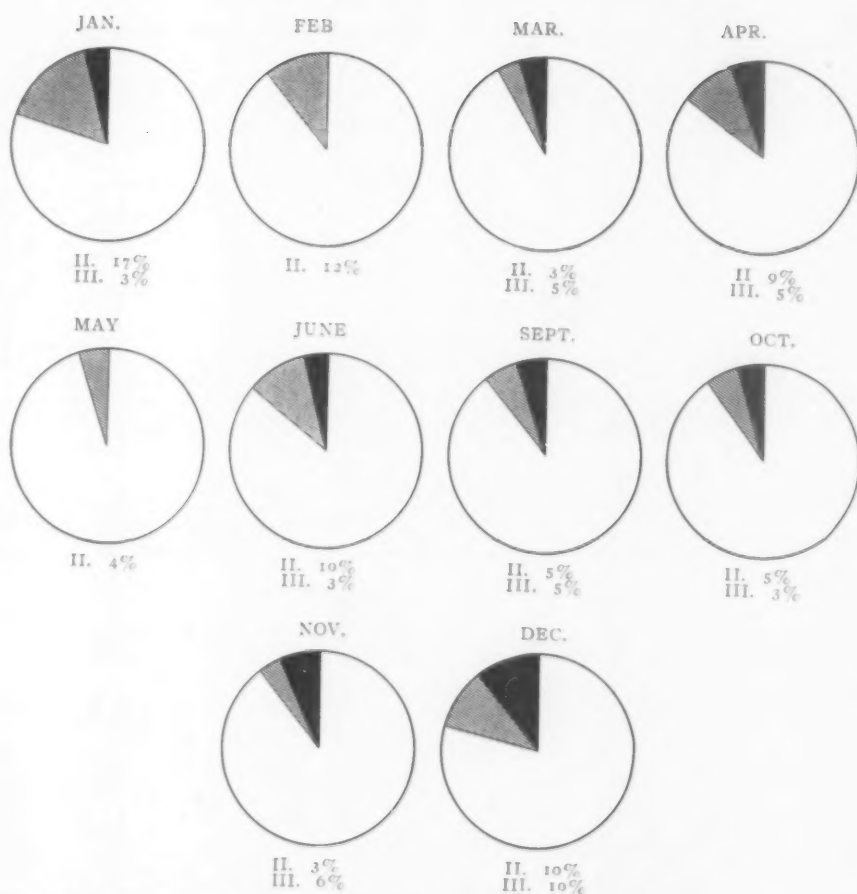


FIG. 1.—Results of wound healing—1920. Class I. (white) Ideal wound healing. Class II. (shaded) Slight Mishaps. No detriment to wound healing. Class III. (black). All Infections.

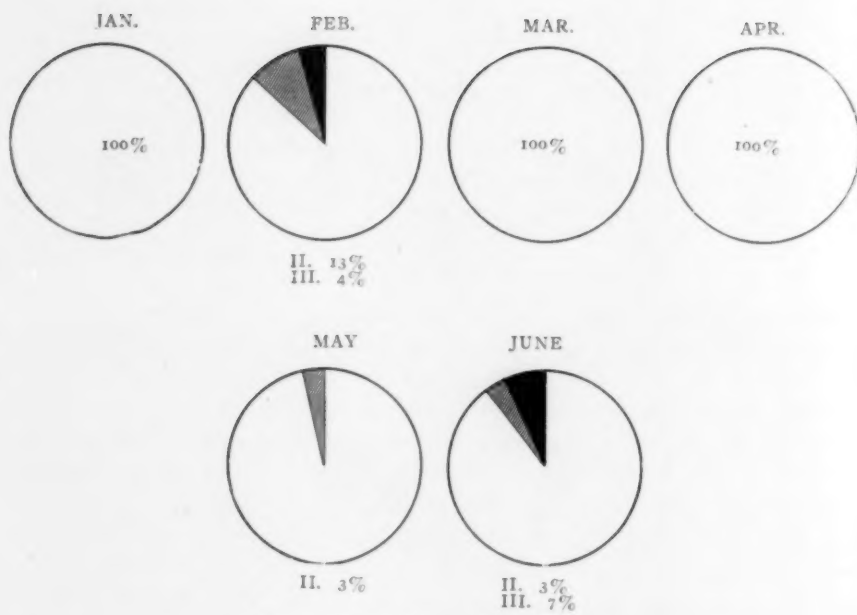


FIG. 2.--Results of wound healing--1921.



## STANDARDIZED RESULTS OF WOUND HEALING

### CONCLUSIONS

This paper is not intended to exploit our results and we wish again to insist that the operations here reported do not represent our total series but merely a limited group of cases which we believe is a fair index of our probable results. What we wish to emphasize is the great importance in a hospital service of carrying out systematically and continuously such an investigation. The psychical stimulus and interest are most pronounced and helpful.

## THE SURGICAL REMOVAL OF PANCREATIC STONES\*

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PANCREATIC stones occur so infrequently that one is seldom called upon to remove them surgically. A review of the literature shows very few cases in which a pancreolithotomy has been performed. It is probable that such stones are often overlooked during the course of abdominal explorations, as they have been found at autopsy on a number of occasions. The consistency of the pancreas is probably responsible for the difficulty with which they are recognized at operation. When multiple stones are present a sense of crepitation is brought out upon palpating the gland, which makes the diagnosis easy; but single stones are difficult to recognize when palpated through the pancreatic tissue. In reviewing the histories of the patients operated upon for pancreatic calculi in the Mayo Clinic, I find that during eleven years this operation has been performed only four times. It is customary in this clinic to routinely examine the pancreas in all patients operated upon for upper abdominal disease, and the fact that so few pancreatic calculi have been found by surgeons who routinely examine the pancreas during this time shows that pancreatic calculi are either extremely rare or very difficult to recognize at operation. The presence of stones in the pancreas was first reported by Graaf in 1667, and the first report of the surgical removal of stones was probably that of Mr. Pierce Gould in 1896. Since then case reports have occasionally been published, but to the present time the list of reported cases is extremely small.

Pancreatic calculi very closely resemble the calculi found in the ducts of the salivary glands. They are usually of white or slightly gray color, fairly firm in consistency, brittle and irregular in shape; however, they may be faceted on a portion of their surface, as was seen in the stones removed from one of our patients. Chemical analyses which have been made have shown that they are composed of carbon salts, phosphorus or magnesium salts and organic matter.

As there is still considerable controversy as to the etiology of pancreatic diseases it is impossible to say just how these stones are formed and what part they might play as a factor in pancreatic disease. It would seem, however, that the manner of their formation must be very similar to that of stones in the biliary tract, that is, from infection in the ducts or from the stagnation of pancreatic fluids from obstruction.

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\* Read before the American Surgical Association, June 15, 1921.

## SURGICAL REMOVAL OF PANCREATIC STONES

Diabetes has often been observed associated with pancreatic stone, Hansemann in seventy-two cases of diabetes associated with pancreatic disturbances found stones in twelve cases, and Oser in seventy cases of lithiasis observed that diabetes was recorded twenty-four times. It is difficult to say just what part, if any, these stones played in the production of the diabetes. It seems most likely that both the diabetes and the stones had resulted from the chronic inflammatory changes in the pancreas but it is possible that the diabetes may have resulted from the chronic inflammatory changes in the gland produced by the calculi.

Pancreatic calculi have been reported in some instances where pancreatic cysts were present and it is probable that they are responsible for the formation of certain of these cysts.

The symptoms produced by stones in the pancreas are so very similar to those seen in chronic pancreatitis associated with stones in the biliary tract that a definite diagnosis of their presence in the pancreatic ducts is impossible. The presence of stone may be suspected and several cases have been reported in which such a diagnosis was made and was later confirmed at operation, but a definite diagnosis can be made only at operation. On account of this difficulty in diagnosis, the pancreas, during the course of operations for infection or stones in the biliary tract, should be carefully palpated for evidences of stone.

Pancreatic calculi may be single or multiple or may entirely fill both of the pancreatic ducts. They also have been found near the periphery of the gland, where they have formed in the small ducts. When they are located in the ducts near the point where these empty into the duodenum they may often be recognized at operation by careful palpation; when multiple stones are present they may be recognized by the peculiar feeling of crepitation which they impart to the palpating hand upon manipulation of the gland. It is difficult to decide definitely as to the character of localized tumors in the head of the pancreas, as these may be due either to neoplasms or to impacted stones surrounded by an area of inflammation. In one of the cases operated on here, as in a case reported by Link, a distinct ridge was present on the anterior surface of the gland which corresponded to the course of Wirsung's duct, which could be felt throughout the entire length of the pancreas.

Up to the present time very few operations have been performed upon the pancreas proper, and in most instances the chronic inflammatory diseases of this gland have been treated indirectly by drainage of the gall-bladder or common duct. Experimental work done by Opie, Coffey, Sweet and others tends to show that surgery of the pancreas is not necessarily attended with the risk commonly supposed to be present. Operations for the removal of

pancreatic stones present no unusual difficulties except in instances where the stones are impacted in the ducts near the ampulla, and, I believe, can usually be performed safely. When operating for stones the pancreas should be exposed by the route which seems to offer the best exposure of the gland. If the stomach is high, exposure can be best obtained through the gastrocolic omentum; while if the stomach is low, it can best be exposed through an opening in the gastrohepatic omentum. The pancreas also has been exposed by lifting up the omentum and colon and making an incision through the transverse mesocolon. Stones have been removed from the lower portion of the duct of Wirsung through an incision through the mesentery of the duodenum, and cases have been reported in which the anterior wall of the duodenum has been opened and stones removed by incising the papillæ of Vater and the posterior wall of the duodenum, thus exposing the ampulla and the end of the pancreatic duct. Following the removal of calculi, hemorrhage may be easily controlled and the opening in the duct closed without difficulty with small silk sutures. In the case reported by Link the tail of the pancreas was drawn out through an opening made in the transverse mesocolon, and after the stones had been removed a catheter was used to drain the pancreas, the tail of which was drawn out through the abdominal incision.

The ducts of the pancreas are without valves, and in cases of obstruction where pancreatic drainage is thought advisable it is possible that an operation of the type described by Link or that described by Coffey, in which the cut-off end of the pancreas is transplanted into the jejunum, might be done. In the four cases operated on in the Mayo Clinic the openings in the pancreatic duct were closed and rubber tissue drains used to take care of any pancreatic fluids which might escape. The experimental work of Opie, which has been confirmed by Coffey and others, has shown that fat necrosis occurs only when pancreatic fluid is poured into and confined in the retroperitoneal fat; when pancreatic fluid is delivered inside the unbroken peritoneum, fat necrosis does not occur, and no harm can result from this provided sufficient drainage is placed to readily conduct the pancreatic fluid to the surface. It would seem safest, therefore, in operations where the pancreatic ducts are opened, that some provision be made for carrying off the pancreatic fluid in case leakage should occur.

I wish to report in this paper four cases operated on in the Mayo Clinic since 1910:

**CASE I.**—Female, aged forty-eight years. For fourteen years the patient had attacks of sudden, sharp, cramp-like pains in epigastrium, radiating through to the back, accompanied by nausea and often by deep jaundice; for many years a good deal of flatus and diarrhœa, often having as many as twenty-five stools, without blood or mucus, in twenty-four hours. Jaundice for one year. Considerable weight and

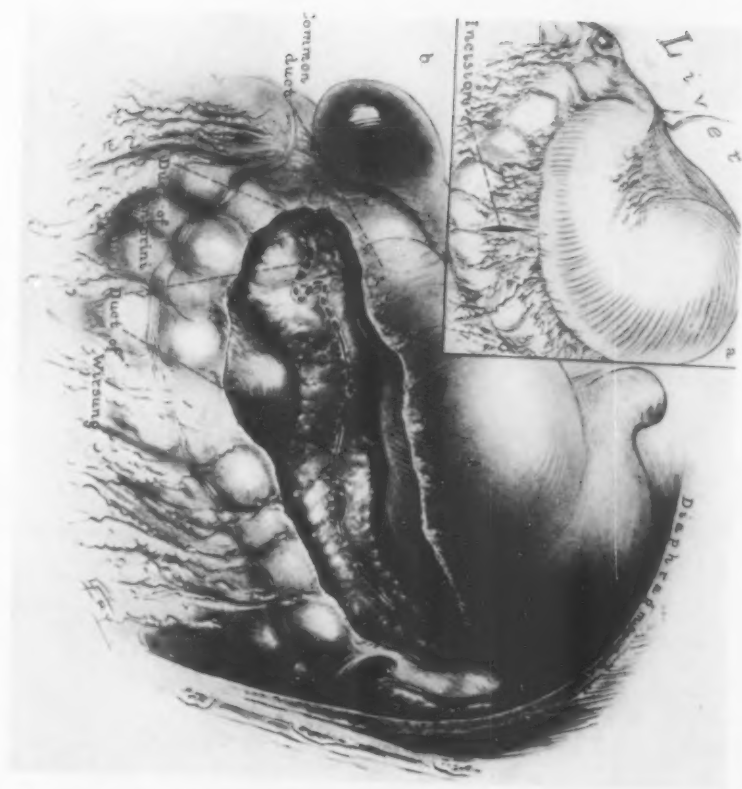


FIG. 1.—*a*. Incision in the gastrocolic omentum. *b*. Opening in the lesser peritoneal cavity and incisions along the course of the pancreatic duct. The gastrocolic omentum has been divided extensively in order to show the entire pancreas.

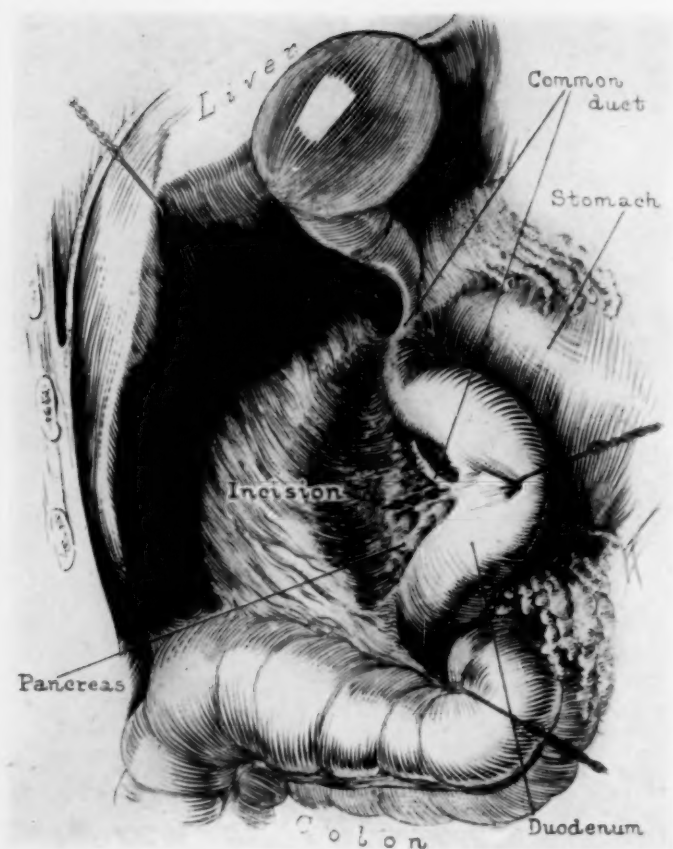


FIG. 2.—The mesentery of the duodenum is incised and the duodenum turned back in order to expose the head of the pancreas.



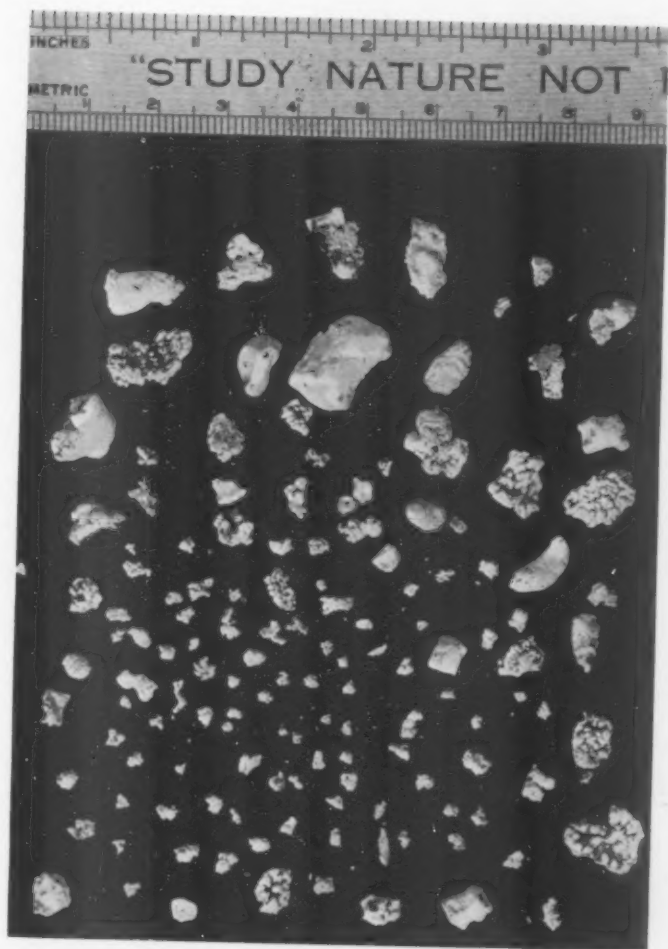


FIG 3.—(Case A288735). Pancreatic stones.

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## SURGICAL REMOVAL OF PANCREATIC STONES

strength loss. A diagnosis of gall-bladder disease with probable common duct stones was made. Operation June 16, 1910. A stone the size of a filbert and several smaller ones removed through an incision in the anterior wall of the duodenum; this stone found in a diverticulum in the head of the pancreas just off from the common duct at a point about one-half inch above the papilla. Ampulla opened for distance of about one-half to three-fourths of an inch. Gall-bladder largely destroyed; remnants of it removed. Spleen four times normal size. Patient also had pyloric obstruction from chronic duodenal ulcer and at another operation a gastroenterostomy was made. Two years later she was in excellent health.

CASE II.—Male, aged thirty-three years. History typical of gall-stones for several years. One year previously operated upon elsewhere with removal of stones from gall-bladder and common duct; drainage of gall-bladder. Pancreas found to be enlarged and thought to contain stones, but no attempt to remove them. When examined in Mayo Clinic patient found to have diabetes; sugar disappeared from urine under treatment and strict diet. Operation October 1, 1919. Enlarged gall-bladder which was free from stones. Two stones removed from common duct. Pancreas slightly enlarged and quite hard. Peculiar crepitating feel imparted to hand upon palpating pancreas, and a ridge could be felt on anterior surface of the gland corresponding to the course of the duct of Wirsung, which extended from the tail to the head. Pancreas exposed through opening in gastrocolic omentum and many stones removed through four incisions in the duct of Wirsung. Several stones in the duct near the ampulla removed through an opening made through mesentery of duodenum. Openings in the duct closed with small silk sutures. Gall-bladder and common duct drained. Several rubber tissue drains. Duct of Santorini seemed filled with stones, but on account of extent of operation already performed no effort made to remove these stones. Diabetic condition improved considerably after operation and sugar tolerance became much increased. Lately patient has had symptoms indicating that infection is still present in biliary tract.

CASE III.—Female, aged sixty-eight years. Attacks of epigastric pain radiating to left side but not to the back for some years. Fifteen pounds weight loss within past year. Appendix found to be definitely diseased. Multiple stones could be palpated in head of pancreas. These removed through opening made through mesentery of duodenum. Stones appeared to be in main duct of pancreas but were near surface. Uneventful recovery. No subsequent notes.

CASE IV.—Female, aged sixty-two years. History of ulcer of duodenum for fifteen years. X-ray showed pyloric obstruction. Unable to obtain history of gall-bladder trouble. Operation January 1,

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1921. Chronic perforating duodenal ulcer with pyloric obstruction found. A stone could be felt by palpation in pancreatic duct near ampulla. Opening made in duct through mesentery of duodenum and two stones size of navy beans removed. Gastroenterostomy made. Good recovery. No subsequent notes.